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PUBLICATIONS

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POSSIBILITY OF MEASUREMENT OF THE MASS OF A BODY IN INERTIAL AND NONINERTIAL SYSTEMS OF REFERENCE

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 30, No 10, 1986
(manuscript received 19 Nov 85) pp 921-924

[Article by V. V. Katsygin and Corresponding Member, Belorussian Academy of Sciences, G. I. Sidorenko, Belorussian Scientific Research Institute of Cardiology]

[Abstract] A method of measurement of the mass of a body under inertial and noninertial conditions such as space flight with or without acceleration is suggested. The method is based on measurement of the resonant frequency of forced oscillations of a sprung mass. A device for measuring the body mass of an astronaut is diagrammed, including a chair with retaining strips, a rocking force generator, hinges and springs. By strapping himself into the chair and starting the rocking motor, the astronaut can determine his body mass with an error of less than 1%. Figure 1, reference: 1 Russian.

6508/5915
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UDC 62-501.52

SINGLE-CONTOUR SYSTEMS WITH SEVERAL NONLINEARITIES SATISFYING THE GENERALIZED EISERMAN-KALMAN HYPOTHESIS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292, No 6, 1987
(manuscript received 22 Oct 85) pp 1315-1318

[Article by M. I. Gil', Khabarovsk Complex Scientific Research Institute, Far Eastern Science Center, USSR Academy of Sciences]

[Abstract] A class of single-contour systems with several differentiable non-linearities is delineated, satisfying the generalized Eiserman-Kalman hypothesis. References: 7 Russian.

6508/5915
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UDC 62-50

FORCED OSCILLATIONS IN SYSTEMS WITH HYSTERESIS NONLINEARITIES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292, No 5, Feb 87
(manuscript received 1 Oct 85) pp 1078-1082

[Article by A. M. Krasnosel'skiy]

[Abstract] Frequency criteria are suggested for the existence of periodic oscillations in control systems with hysteresis nonlinearities. The new results are also applicable to systems with purely functional nonlinearities without hysteresis elements. This article also presents and discusses a general principle of solvability of nonlinear operator equations, which forms the basis of a proof of the theorem of forced periodic oscillations. This principle is based on a new theorem suggested in the work on estimates of the norms of solutions of special integral-functional inequalities. Examples of applications are presented. References: 12 Russian.

6508/5915
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UDC 681.51.015

FILTRATION, CONTROL, DETECTION UPON SUDDEN BREAKDOWN

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 293, No 1, 1987
(manuscript received 22 Jul 85) pp 45-47

[Article by I. A. Boguslavskiy, Moscow Physical-Technical Institute, Dolgoprudnyy, Moscow Oblast]

[Abstract] A sudden breakdown refers to failure of a component or development of external noise or interference. Optimal information processing and control algorithms must consider the possibility of such a sudden breakdown which changes the functioning of the entire system. This article solves three problems which arise under such conditions: determination of the vector of a posteriori mathematical expectation of the vector of phase coordinates for a linear system; synthesis of optimal control for such conditions; and detection of the random moment of breakdown. Solution of the first two problems is demonstrated not to require solution of the third, which indeed must be solved only if detection of a breakdown permits protective action such as replacement of a failed component. References: 2 Russian.

6508/5915
CSO: 1863/250

AUTOMATION OF PRODUCTION

Minsk SELSKOYE KHOZYAYSTVO BELORUSSII in Russian No 1, Jan 86 pp 24-25

[Article by S. A. Ivanov, "Automation of Production"]

[Text] Significant work is taking place in the plants of the republic's agro-industrial complex in further raising labor productivity and lowering the costs with respect to bringing into production new machines and mechanisms which have a high level of mechanization and automation of technical processes. At the same time, the production management system is being improved on the basis of the application of computer technology and economic-mathematical methods.

For instance, in the Polotsk vehicle-repair plant in the production lines for replacing cylinder blocks of the GAZ-51 and ZMZ-53 [engines], at the stations for balancing and installing cranks in the blocks, seven balance manipulators have been introduced and are being used successfully. Analogous hardware is being used at the Lida vehicle-repair plant and a number of other repair projects. Each such set of equipment significantly lightens the labor of many people, raises productivity 15 to 30 percent and provides an economic impact up to 2,000 rubles per year.

Last year many repair enterprises got down to the introduction of industrial robots using robotized produc ction complexes (RTKs). This work is proceeding in a systematic manner at the Polotsk vehicle repair plant and the Minsk experimental engineering plant. Robotics will be used for the first section in the sheet stamping section, and for the second one in preparing armature plates for submersed electric pumps. Likewise, the Kazimirov experimental plant and the Lida vehicle repair plant are actively equipping the labor-intensive production with robotized units, and this provides a great productive and economic effect.

A goal-orineted program has been worked out and is being implemented now to introduce the means of mechanization in repair enterprises of the agricultural system for the period until 1995 inclusive. In particular, in the 12th Five Year Plan, this program establishes the introduction of 4 automated sections, 32 industrial robots in 26 robotics systems, and 318 balance manipulators.

The realization of these functions will lighten the labor of about 1,000

workers with dangerous and difficult conditions of labor. Besides this, in the basic production up to 400 men will be freed up. The quality of production will significantly rise, and there will be an increased output without increasing the number of people.

The main organization which is involved in introducing robotics is the industrial engineering institute "Sel'khoztekhproyekt". [expansion unknown]. An industrial design department has been especially created. It has developed the necessary documentation for a series of special gripper and storage devices for incorporating balanced manipulators in the repair enterprises.

In this direction, there is active scientific and technical cooperation with specialists from other departments. With their participation on the Polotsk vehicle repair plant, using fully adjusted robotized modules, there will be created sections for centralized replacement of engine cylinder liners for the GAZ-53, GAZ-24, SMD-60/62 engines, and engine connecting rods for the GAZ-53, ZIL-130, GAZ-51, GAZ-24 engines, and so forth. In the Minsk oblast,' plans exist to equip the automated spare parts warehouse of the regional facility with carrying racks.

The program of industrial re-tooling anticipates a wide-ranging introduction of highly productive equipment with digital program control. In the 12th Five Year Plan, there are also plans to create five sections for centralized manufacturing of components at the Priyaminsk, Orshansk, Polotsk, Kobrin, and Lida repair plants.

At the Priyaminsk repair plant 15 stations have already been installed with digital program control. The section is equipped with new equipment for program preparation. At the present time the manufacturing of more than 20 very complex components has begun. Further, at the plant a special center has been created for machining the chassis components for the T-150K tractor. Plans exist also for introducing a set-up section for cutting round bars with a crane arm at the facility with three sections under digital program control. One operator will maintain the section.

Analogous automated sections will be introduced at all enterprises enumerated above. In the framework of this program, at the Orshansk tractor repair plant there have already been successfully installed two machine tools under digital program control, equipped with an advanced operations management system. The operator prepares programs directly on the machine tool. At this same plant in the very near future will be installed two centers for manufacturing transmission casings for the ZMZ-53 and the GAZ-51. In all, in the current five-year plan, there are plans to introduce 73 machine tools with digital program control, of which 5 machines are "machining centers". This will allow the freeing-up of about 100 machine-tool operators and auxiliary workers, replace more than 90 units of physically obsolete metal-cutting equipment, and newly create 5 automated set-up sections.

At the repair enterprises, the systems for running-in the internal combustion engines are being actively automated. The running-in test stands, supplying program management for the technical systems, were developed under an equipment contract with the Belorussian Institute of Agricultural

Mechanization, and were installed in the Uzden rayon and at the Dzerzhinsk motor repair plant. At the Mogilev repair plant, a test stand has been installed for running-in the SMD engines in an automated system with all parameters controlled. Five more such stands have been specified at other repair enterprises.

For management of material and technical supply for kolkhozes and sovkhozes, the ASU-MTS automated system has been developed and is successfully being employed, encompassing four levels of management (warehouse -- rayon -- oblast' -- republic). It contains accounting for stock levels, movement of goods, raw materials, and exchange funds. The "Robotron-1840" minicomputer and YeS-1022 computer are used for this purpose. This permitted full mechanization of labor-intensive operations, freeing-up 370 accounting clerical workers (keypunchers and operators) at the main facility and at the warehouses.

With the help of computer technology, fulfillment of contract conditions in regard to delivery of products is controlled. Its entire product list, which it receives from 2,100 suppliers, is constantly held in computer memory. From the computer are printed operational instructions for the receipt of any goods, and penalties are calculated for their insufficient delivery and so forth. This has helped significantly raise contractual compliance among the factory-suppliers. The percent of sales of industrial products to collective farms (with accounting of the products list) rose from 93% in 1980 to 98% in 1984.

An information retrieval system is widely employed, using teletypes. It permits the user at any time to commence communication with the computer at the republic or oblast' data processing center, and immediately receive necessary information regarding the availability of spare parts or other goods. This permits more practically satisfying agricultural requisitions, quickly eliminating technical breakdowns in the machine and tractor stock. The entire products list of spare parts at the republic level, and that set up (about 3,000 designations) at the oblast' level is distributed on the computer. This has made it possible to send out supply authorizations promptly to all users, and send out funds to the users 25 to 30 days earlier. It has significantly improved the planned supply of agricultural and other organizations of the agricultural-industrial complex, from the very beginning to the end of every new year.

The computer likewise calculates the demand for fuel and oil materials and their allocation. It can do this for all 117 rayons of the republic by consolidating the consumption demand for motor fuel and oil at the oblast' and republic levels. These calculations have permitted more exact definition of the quantity of oil products which are necessary for the republic's agricultural system; free specialists in oil supply from hand calculations; and provide greater attention to the economical and rational utilization of the funds allocated for fuel and oil materials.

The immediate problem today appears to be to raise the level of automation of management of production processes directly at the plants. In order to create automated workplaces for accountants, economists, engineers, and other

specialists, new computer technology is needed. With the help of display screens and automatic printers, they will receive summaries, reports, and information from the computer memory. At the present time, they are carrying on experimental usage of projects of automated processing of operational information with the help of 12 CRTs at the republic supply center. Plans are being formulated for processing dispatcher information in the rayons; for accounting of vehicle transport operations; for technical maintenance of machinery and equipment at livestock breeding farms and complexes; for accounting for the repair fund and the availability of machinery; and so forth.

The automated data bank allows for receiving, on the local and remote YeS-7920 devices (16-user), necessary inquiry information about the availability of spare parts, machine assemblies, machine units, and fuel/oil materials at various facilities and warehouses. One will have concrete information about the quantitative make-up of the agricultural machinery stock in the facilities of the republic; data about the progress in fulfilling the delivery plan by factory-suppliers; and results of analysis of the administrative and economic activity of plants and organizations.

At the republic level, problems are being attended to in regard to calculating the demand in spare parts for capital renovations, and in materials for industrial production for the plants of 300 repair works. The development and introduction of automated management systems in repair works is being carried out using the SM-1630 computer and the "Robotron-1715" minicomputer. Their introduction will permit even more successfully managing the important processes in repair productivity and in the material and equipment maintenance of agriculture.

13264
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CLASSIFICATION SYSTEMS AND DOCUMENTS, No 9, 1986

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, 1986 pp 1-27

[Table of Contents and cover-to-cover translation of "Classification Systems and Documents]

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The material was prepared by the Main Scientific Research Center for Maintenance of Unionwide Classification Systems (GNITsVOK), and was received at the VNIIKI [All-Union Scientific Research Institute of Technical Information, Classification and Coding] by 10 July 1986.

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COMPUTER-AIDED DESIGN OF DATA BASE ORGANIZATION AND MANAGEMENT FOR AUTOMATED CONTROL SYSTEMS BY USING A PERSONAL COMPUTER

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 1-6

[Article by N. Yu. Kovalkova (Pishchepromavtomatika NPO [Industrial Science Association for Automation in the Food Industry])]

[Text] Designing the data base organization and management for an automated control system is a very laborious process.

In developing the data base organization and management for a system, the following basic problems are solved:

development of classification systems of technical and economic information and creation of a system-wide base of classification systems on machine media for servicing problems in automated control systems;

development of standard forms of input and output documents and creation of a reference file of standard forms of documents on machine media;

definition of the composition and structure of a data bank of economic indicators as centralized storage for use in integrated solving of problems in automated control systems and furnishing information to system users;

maintenance of the data base organization and management for a system in a current status.

With the traditional method of design, implementation of these efforts (with a rather large number of problems to be solved in automated control systems under the conditions of considerable limits on labor costs) becomes complicated and not very efficient.

Contemporary requirements of raising the efficiency and quality of the labor of developers are met by a system for computer-aided design of data base organization and management (SAPIO), implemented on the ISKRA-226 personal electronic keyboard computer (PEKVM) by using the VELOBAD software engineering package (PTK).

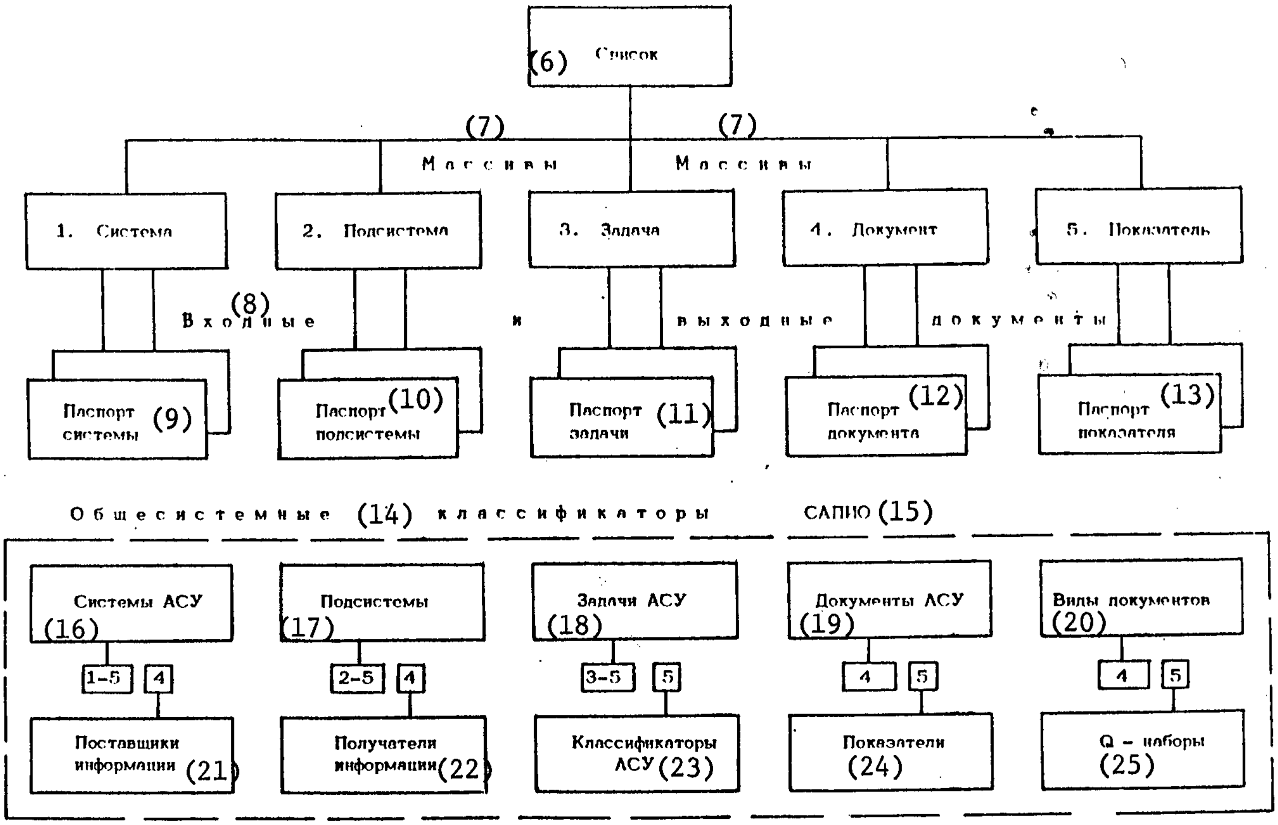

Fig. 1. Structure of information base of SAPIO [system for computer-aided design of data base organization and management]

Key:

1. System
2. Subsystem
3. Task
4. Document
5. Indicator
6. List
7. Files
8. Input and output documents
9. System descriptor
10. Subsystem descriptor
11. Task descriptor
12. Document descriptor
13. Indicator descriptor
14. System-wide classification systems
15. SAPIO [system for computer-aided design of data base organization and management]
16. Systems in automated control system
17. Subsystems
18. Automated control system tasks
19. Automated control system documents
20. Types of documents
21. Information suppliers
22. Information recipients
23. Automated control system classification systems
24. Indicators
25. Q - sets

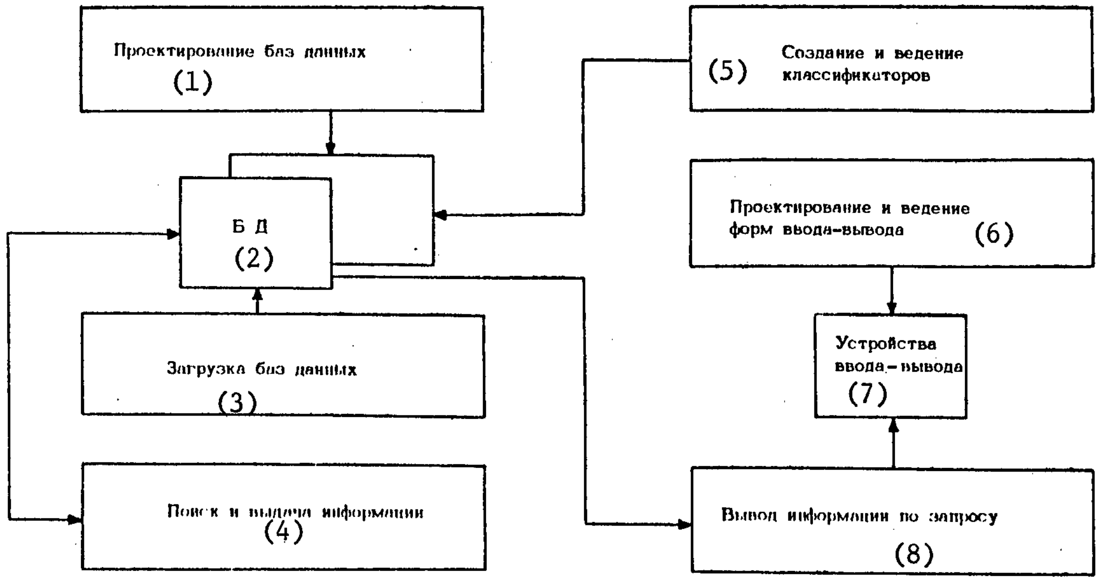

Fig. 2. Functional structure of SAPIO [system for computer-aided design of data base organization and management] implemented by using VELOBAD PTK [software engineering package]

Key:

1. Design of data bases
2. BD [data bases]
3. Loading of data bases
4. Information retrieval and output
5. Development and maintenance of classification systems
6. Design and maintenance of input/output forms
7. Input/output devices
8. Output of information upon request

The purpose of the development of the SAPIO [system for computer-aided design of data base organization and management] is to reduce expenses for the development and maintenance and the time for design of the data base organization and management for automated control systems.

The SAPIO [system for computer-aided design of data base organization and management] is intended for:
development of the reference file of forms of documents, the file of classification systems, the forms of documents and the technical and economic indicators included in the general-purpose data bank;
development of the system reference information bank (basic characteristics of systems, subsystems, tasks, documents);
standardization of forms of documents;
automated maintenance and preparation of design documentation.

The structure of the information base of the SAPIO [system for computer-aided design of data base organization and management] is shown in fig. 1.

Each file contains the set of basic characteristics of the object of data base organization and management most often used to analyze the construction of an automated control system, and to obtain the various design characteristics of a system and the reference information necessary for development of an automated control system and further design of it.

Using the SAPIO [system for computer-aided design of data base organization and management] allows, along with reference information function, ensuring the standardization of the information base being developed and reducing the number of input and output forms with centralized preparation and maintenance of them and the number of technical and economic indicators to be stored.

The language of K-standards is used to describe the technical and economic indicators in the system. In doing so, each indicator is uniquely assigned a Q-tuple of features.

The files of indicators in the SAPIO [system for computer-aided design of data base organization and management] are records of a uniform structure consisting of a set of data called indicators and identified in a file by codes. Descriptive information is contained in the classification systems in the SAPIO [system for computer-aided design of data base organization and management]. The names of the information files are stored in the List file. The classification systems are designed for checking the input indicator, storing the title of the indicator, and outputting the full title instead of the code to output documents.

The functional structure of the SAPIO [system for computer-aided design of data base organization and management] implemented by using the VELOBAD PTK [software engineering package] is shown in fig. 2.

The composition of the technical and economic indicators and the basic informational characteristics of them are defined in the data base design block. Information files are created on magnetic media (disk or diskette) as a result of data base design. In the base design process, the composition and basic characteristics of indicators can be changed.

After creation of the classification systems, the number of which matches the defined indicators of a file, declared coded, the user loads the files with the initial data. In accordance with the file description, data can be entered without an input document form or according to a form previously designed in the input/output form design block.

In the process of data entry or after it, a user can update the data by system facilities thereby keeping the data base current.

The reference information function of the SAPIO [system for computer-aided design of data base organization and management] is implemented in the blocks for retrieval and output of information upon requests. In the process, data is output according to forms in accordance with the set of retrieval features specified by the user. The SAPIO [system for computer-aided design of data base organization and management] also supports the output of fixed requests,

the forms of output and composition of features of which have been previously defined. Wide (up to 128 characters) and narrow (up to 80 characters) document forms can be output to both the display screen and the ATsPU [alphanumeric printer].

When a user cannot obtain output information by using the standard VELOBAD PTK [software engineering package] facilities, his algorithms can be implemented in programs written in the BASIC language with VELOBAD restrictions.

System utilities allow operation with peripherals, coding, deletion of files or formatting of disks.

The data base organization and management can be described by the REDIS system facilities, which allows storing texts by pages on magnetic disk and editing of text, including the following functions: read/write page from/to disk, edit page, print document pages, change page format, replace pages.

The SAPIO [system for computer-aided design of data base organization and management] as a facility for computer-aided design of data base organization and management allows executing this work simultaneously for several developers autonomously or jointly with distribution of a data base to the separate devices of one or more Iskra-226 PEKVM [personal electronic keyboard computers].

The SAPIO [system for computer-aided design of data base organization and management] described was used in developing system-wide solutions for data base organization and management in the ASU-Soyuzpishcheprom [Automated Control System for the All-Union Association of the Food Industry].

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REVISION OF CLASSIFICATION SYSTEM FOR MANUFACTURING OPERATIONS IN MACHINE BUILDING AND INSTRUMENT MAKING IN THE TECHNICAL TEST SECTION

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 6-8

[Article by V. N. Chupyrin and L. A. Sergeyeva (Gorkiy Branch of VNIINMASh [All-Union Scientific Research Institute for Normalization in Machine Building]

[Text] Use of the unionwide classification system for manufacturing operations [1], including technical test operations, has confirmed the correctness of the principles adopted during development of it. The emergence of new test methods and means, new standards documents (GOST [State Standard] 24642-81 "Basic Norms of Interchangeability. Tolerances of Form and Geometry of Surfaces. Basic Terms and Definitions"; and GOST 18353-79 "Nondestructive Testing. Classification of Types and Methods") and the Classification System for the YeSKD [Unified System of Design Documentation] [2] have caused the necessity of revising and improving the classification system for manufacturing operations.

The classification of the manufacturing operations for technical testing (TOTK) in the new edition of the classification system is built on the hierarchical method in which a given set of operations is sequentially divided into subsets [8].

Introduction of the classification system for manufacturing operations for the Technical Test section has shown that the adopted features of the classification of the manufacturing operations for technical testing--the type of physical values being tested, and the sort and variety of features and parameters being tested--are the most effective. Therefore, in revising the classification system, these features were kept and another one--the subtype of parameters being tested--was added to them.

In the first stage of classification (by type of physical values being tested) with regard to the CEMA standard 1052-78, "Metrology. Units of Physical Values," 13 manufacturing operations are identified instead of the 18 in the old edition of the classification system. In the process, only 6 of them retain the previous titles (test of values of space and time, test of mechanical values, test of thermal values, test of values of physical optics, test of acoustic values, and test of values in the field of ionizing

radiations). The titles of 4 manufacturing operations were made more precise, which is due to the requirements of the CEMA ST [Standard] 1052-78 (testing of electrical and magnetic values, testing of light values and electromagnetic emissions associated with them, testing of values of physical chemistry and molecular physics, and testing of other values and characteristics).

The classification system in effect also lacked major manufacturing operations such as testing of periodic values, comprehensive testing of physical values, and testing of qualitative characteristics.

In the new edition of the classification system, such an operation as nondestructive testing which, being a generic concept for the types of nondestructive testing, does not find separate application as independent, has been excluded.

The other testing operations in the first stage of classification in the classification system in effect have been placed in subsequent stages of classification (testing of quantity of pieces, testing of functioning, testing of external type).

In the second stage of classification (by type of features and parameters to be tested), the set of operations is divided into subsets. A total of 12 testing operations has been identified. The titles of the following operations have been made more precise: testing of the state of material, testing of force, and testing of mass. A number of operations have been excluded in connection with the absence of values characterizing these operations in the CEMA ST [Standard] 1052-78.

A feature of classification in this stage is that operations such as testing of length and comprehensive testing of geometric parameters have also been included among the operations for testing of values of space and time. The length test operation is introduced as a generic concept for operations in the third stage of classification. Also included in it are testing operations such as testing of linear dimensions, dimensions of curvilinear surfaces, geometry of surfaces, surface form, and surface form and geometry.

The operation of comprehensive testing of geometric parameters is also a generic concept for major testing operations such as testing of roughness of parts and testing of spline, threaded, toothed, and worm parts, which are a subset of operations in the third stage.

Operations found mainly in the third stage of classification (by subtype of parameters to be tested) are the operations of testing of length and comprehensive testing of geometric parameters which were discussed above.

In the fourth stage of classification (by varieties of parameters to be tested), specification of manufacturing operations of technical testing of geometric parameters, which accounts for about 90 percent of technical testing labor, is advisable. This stage has 13 testing operations. The following testing operations have been excluded: testing of misalignment of

axis from nominal position, testing of tightening torque, and nine operations of testing of toothed and worm gears since they are not in GOST [State Standard] 24642-81. At this level, the titles of some operations on the deviation of the shape and geometry of surfaces, for example testing of flatness, parallelism and roundness, have also been made more precise [2].

This classification system of manufacturing operations in machine building and instrument making will be introduced in January 1987.

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UDC 002.003.13:025.4

DETERMINING ECONOMIC EFFECTIVENESS OF INTRODUCTION OF UNIFIED DOCUMENTATION SYSTEMS

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 8-14

[Article by N. G. Palamarchuk]

[Text] In connection with the necessity of determining the economic effectiveness of the introduction of unified documentation systems (USD) and unionwide classification systems of technical and economic information (OK TEI) as the main components of data base organization and management in automated control systems, the basic methodological principles for computing the national economic effect from introducing them have been established by the Gosstandart [State Committee for Standards].

In addition to the direct economic effect which can be quantitatively assessed, the indirect effect is of great value. It determines changes of a qualitative nature which show up primarily in the improvement of management on the basis of raising the promptness and quality of making decisions thanks to the use of unified data base organization and management in implementing basic functions of management.

The basic indicators of the economic effectiveness of the introduction of unified documentation systems and unionwide classification systems of technical and economic information are computed at the level of both the individual enterprise (association) and by sectors and the national economy as a whole.

The annual economic effect from introduction of a unified documentation system is made up of the economic effects from introduction of the individual unified forms of documents included in the system and is expressed as the relation between the savings obtained from the introduction of the unified documentation system and the expenses for developing and introducing it.

The main sources for obtaining savings from the introduction of a unified documentation system as a whole and individual unified forms of documents are the reduction in the: time for drafting of documents as a result of the standardization of them; consumption of information media and the cost of them; number of errors and quantity of wasted forms when standards for completing individual unified forms of documents are introduced; and the reduction in the cost for operation of the computer hardware.

Let us consider the computation of the basic indicators of economic effectiveness for an enterprise which introduces a unified documentation system.

The annual economic effect $Ee_{a\ UDS}$ (in thousands of rubles) from the introduction of a unified documentation system in an enterprise is determined from the formula

$$Ee_{a\ UDS} = Ee_{UDS} - Ec_{norm} \cdot C, \tag{1}$$

where $Ee_{UDS} = \sum_{i=1}^{n} Ee_{UFD\ i}$ is the annual savings obtainable in an enterprise from the introduction of a unified documentation system, in thousands of rubles;
n is the number of forms included in the unified documentation system and used in the enterprise;
$Ee_{UFD\ i}$ is the annual savings obtainable from the introduction of the i-th form included in the unified documentation system in an enterprise, in thousands of rubles;
Ec_{norm} is the normative factor of economic effectiveness of costs (for standardization, $Ec_{norm} = 0.15$); and
C is the cost for development and introduction of a unified documentation system in an enterprise, in thousands of rubles.

The annual savings $Ee_{UFD\ i}$ (in rubles) is determined from the formula

$$Ee_{UFD\ i} = Ee_1 + Ee_2 + Ee_3 + Ee_4, \tag{2}$$

where Ee_1 is the annual savings obtainable from the reduction in time for drafting a document as a result of standardization, in rubles;
Ee_2 is the annual savings obtainable from the reduction in consumption of information media and the cost of them, in rubles;
Ee_3 is the annual savings obtainable from the reduction in the number of errors and the reduction in waste when standards are introduced for completing the i-th form, in rubles; and
Ee_4 is the annual savings obtainable as a result of the reduction in cost for operation of computer hardware, in rubles.

The following formula is used to determine Ee_1:

$$Ee_1 = (T_1 \cdot Ts_1 - T_2 \cdot Ts_2) \cdot m, \tag{3}$$

where T_1 and T_2 are the times required to process information before and after introduction of the i-th form, respectively, in hours;
Ts_1 and Ts_2 are the costs per hour of information processing before and after introduction of the i-th form, respectively, in rubles/hour; and
m is the number of i-th standardized forms of documents consumed per year.

The following formula is used to determine Ee_2:

$$Ee_2 = (M_1 \cdot Co_1 - M_2 \cdot Co_2), \tag{4}$$

where M_1 and M_2 are the consumptions of information media before and after introduction of the i-th form, respectively, in units/year; and
Co_1 and Co_2 are the costs per information medium unit before and after introduction of the i-th form, respectively, in rubles.

The following formula is used to determine Ee_3:

$$Ee_3 = (O_1 - O_2) \cdot B_o), \tag{5}$$

where O_1 and O_2 are the numbers of errors before and after introduction of the i-th form, respectively; and
B_o is the cost of correcting an error (in rubles), including the cost of checking, finding and correcting an error, and is defined by using expert assessments.

The following formula is used to determine Ee_4:

$$Ee_4 = (T_3 - T_4) \cdot Co_3), \tag{6}$$

where T_3 and T_4 are the annual machine times needed to process information in a year before and after introduction of the i-th form, respectively, in hours; and Co_3 is the cost per hour of computer operation (or other hardware), in rubles/hour.

Costs for development and introduction of a unified documentation system in an enterprise (C) should include costs for:

scientific research associated with developing the unified documentation system;

development of engineering standards documents included in the unified documentation system;

development of individual standardized forms of documents included in the unified documentation system; and

introduction of the unified documentation system.

These costs are determined from the formula

$$C = C_{st} + \sum_{i=1}^{n} C_{dev\ i} + C_{in}, \tag{7}$$

where C_{st} is the cost for development of NTD [engineering standards documents] for the unified documentation system, in thousands of rubles; $C_{dev\ i}$ is the cost for development of the i-th standardized form of a document included in the unified documentation system, in thousands of rubles; and C_{int} is the cost for introduction of the unified documentation system in an enterprise, in thousands of rubles.

The computed factor of economic effectiveness $Ec_{comp\ ent}$ of introduction of a unified documentation system in an enterprise is defined as the relation between the annual savings, obtainable from the introduction of n forms included in the unified documentation system and used in the enterprise, and the costs for development and introduction of them in the given enterprise:

$$\frac{Ec_{comp\ ent} = \sum_{i=1}^{n} Ee_{UFD\ i}.}{C} \tag{8}$$

The computed factor of economic effectiveness is compared to the standard Ec_{norm}. The introduction of standard forms of documents is effective when

$Ec_{comp\ ent} > Ec_{norm}$.

For a sector, the annual economic effect $Ee_{a\ sec}$ (in thousands of rubles) from introduction of a unified documentation system is defined as the sum of the annual economic effects from introduction of a unified documentation system in the k enterprises in the sector which are introducing the system:

$$Ee_{a\ sec} = \sum_{j=1}^{k} Ee_{a\ UDS\ j} \tag{9}$$

where $Ee_{a\ UDS\ j}$ is the annual economic effect from introduction of a unified documentation system in the j-th enterprise of the sector, determined from formula (1), in thousands of rubles.

The factor of economic effectiveness $Ec_{comp\ sec}$ of introduction of a unified documentation system in a sector is defined as the relation between the annual savings, obtainable from introduction of a unified documentation system in k enterprises in the sector, and the total cost for development and introduction of the unified documentation system in the given sector:

$$Ec_{comp\ sec} = \frac{\sum_{j=1}^{k} Ee_{UDS\ j}}{\sum_{j=1}^{k} C_j}, \tag{10}$$

where $Ee_{UDS\ j}$ is the annual savings obtainable from introduction of a unified documentation system in the j-th enterprise of the sector, in thousands of rubles; and
C_j is the cost for development and introduction of the unified documentation system in the j-th enterprise in the sector, in thousands of rubles.

For the national economy as a whole, the annual economic effect $Ee_{a\ ne}$ (in thousands of rubles) from introduction of unified documentation system is the sum of the annual economic effects from introduction of unified documentation systems in the individual sectors. When the annual economic effect from introduction of unified documentation systems in P sectors in the national economy has to be defined, the computation is performed according to the following formula:

$$Ee_{a\ ne} = \sum_{q=1}^{P} Ee_{a\ sec\ q} \tag{11}$$

where P is the number of sectors in the national economy; and $Ee_{a\ sec\ q}$ is the economic effect from introduction of unified documentation systems in the q-th sector of national economy, computed by formula (9).

The factor of economic effectiveness $Ec_{comp\ ne}$ of introduction of unified documentation systems in all sectors of the national economy is defined as the relation between the annual savings from introduction of unified documentation systems in P sectors of the national economy and the total cost for development and introduction of the unified documentation system:

$$Ec_{comp\ ne} = \frac{\sum_{q=1}^{P} Ee_{UDS\ q}}{\sum_{q=1}^{P} C_{sec\ q}}, \qquad (12)$$

The computations can be illustrated by using the example of the introduction of a standardized form of the document "Consignment for Import," which is part of the Unified Documentation System for Foreign Trade, into the V/O Mashinoimport [All Union Association for the Import of Machinery]. Time T_1 = 0.48 hour, T_2 = 0.45 hour (time metering data), cost per hour of information processing $Ts_1 = Ts_2$ = 0.84 ruble, number of forms completed annually both before and after standardization is 200,000, and the annual savings obtained from reducing the time for drafting a document as a result of standardization is

$$Ee_1 = (0.48 - 0.45) \cdot 0.84 \cdot 200{,}000 = 5{,}040 \text{ rubles.}$$

In connection with the standardization, the form size was reduced and the cost per form was reduced from 0.08 to 0.07 ruble, and the annual savings from this was

$$Ee_2 = (0.08 - 0.07) \cdot 200{,}000 = 2{,}000 \text{ rubles.}$$

From the results of expert assessments, the cost of correcting an error is 0.45 ruble. Thanks to standardization and introduction of standards for completing standardized forms of documents, the number of errors per year, from the data of statistical observations in the All Union Association for the Import of Machinery, was cut in half (from 5,400 to 2,700), and the annual savings was

$$Ee_3 = (5{,}400 - 2{,}700) \cdot 0.45 = 1{,}215 \text{ rubles.}$$

In connection with the reduction in annual machine time needed to process the information from 780 (prior to introduction of the form) to 470 hours (after introduction of it), the annual savings when the cost per hour of computer operation is 40 rubles was

$$Ee_4 = 40\ (780 - 740) = 12{,}400 \text{ rubles.}$$

[as published]

The annual savings from introduction of the standardized form of the document "Consignment for Import" is

$$Ee = 5{,}040 + 2{,}000 + 1{,}215 + 12{,}400 = 20{,}655 \text{ rubles.}$$

The budgetary cost for development of the form was 15,000 rubles; therefore, the annual economic effect will be

$$Ee_a = 20{,}655 - 0.15 \cdot 15{,}000 = 18{,}405 \text{ rubles.}$$

The factor of economic effectiveness of introduction of the form was

$$Ec_{comp} = \frac{20{,}655}{15{,}000} = 1.38.$$

This technique provides a standard way of computing the economic effectiveness of introduction of a unified documentation system and will facilitate substantiating the selection of solutions in standardizing forms of documents.

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DYNAMICS OF CHANGES TO CLASSIFICATION PART OF UNIONWIDE CLASSIFICATION SYSTEM FOR INDUSTRIAL AND AGRICULTURAL PRODUCTS

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 14-18

[Article by G. S. Valuyeva, Z. G. Kozina and T. N. Vengerzhitskaya, GNITsVOK [Main Scientific Research Center for Maintenance of Unionwide Classification Systems]]

[Text] The object of classification and coding in the Unionwide Classification System for Industrial and Agricultural Products is a product (including full sets and spare parts, blanks and semifinished products) included in interdepartmental documents and serving as a subject of procurement.

The product groups, coded by six-position codes, are the classification part of the OKP [Unionwide Classification System for Industrial and Agricultural Products] (K-OKP), the maintenance of which is centralized on the basis of lists of changes to the system classification part to be approved, submitted by the ministries (departments) and coordinated with organizations for mandatory coordination.

The Unionwide Classification System for Industrial and Agricultural Products is a dynamic classification system, which results from the numerous changes in the system file, which stem from the emergence of new objects of classification, elimination of obsolete items and change in the titles of groups and from the refinement of them when the code is unchanged.

Since the issue of the Higher Classification Groups (VKG) of the classification system in 1977, 21,490 changes have been made to it (42.4 percent of the total items). In 1983, based on the first issue of the Higher Classification Groups of the classification system and collections of changes Nos 7-37, the standard for the system classification part was established as a paper document in loose-leaf binders.

The system classification part was republished under this standard.

In the period 1984-1985, nine collections of changes were published (Nos 38-46) affecting 2,590 items. In 1984, results of scientific and technical studies produced 1,253 approved changes to the items. In 1985, 1,337 changes were made, including those caused by bringing the system classification part

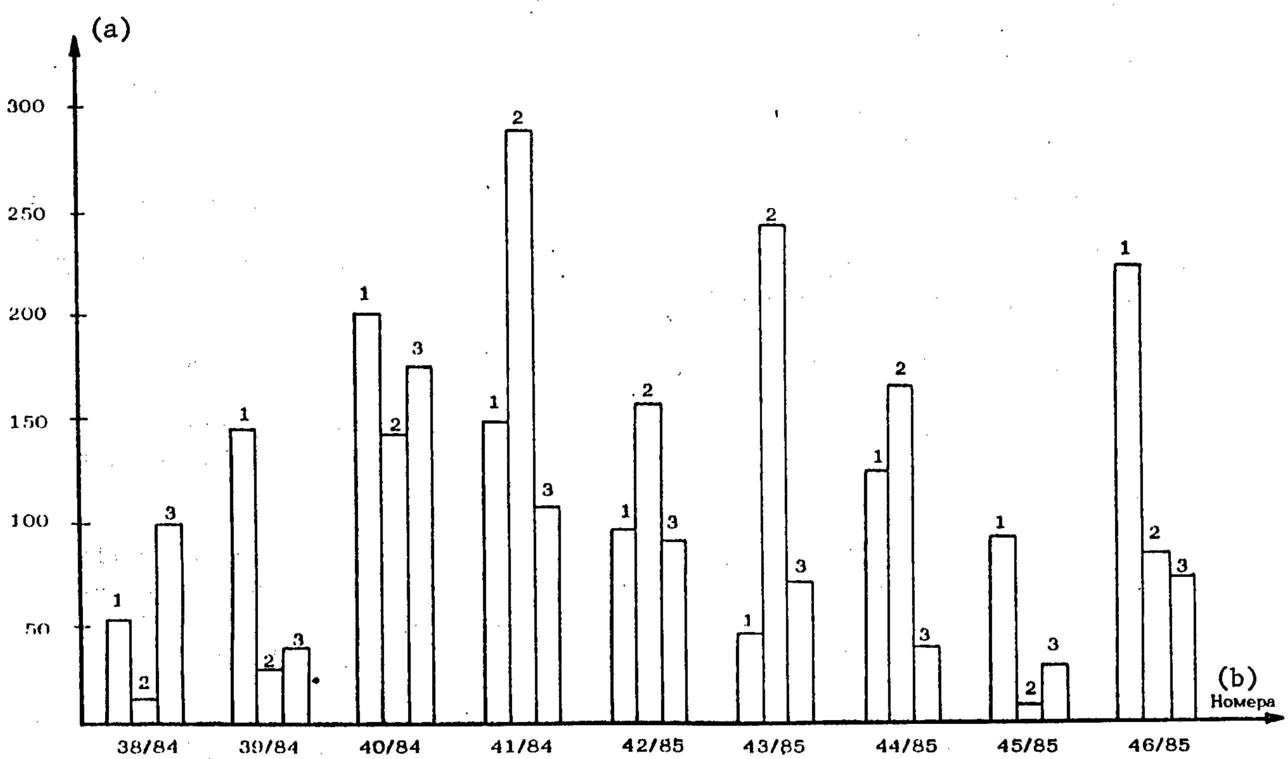

Diagram of distribution of changes from directives

Key:
1. additions
2. deletions
3. revisions (changes)

a. number of changes
b. change list issue

in line with the CEMA system classification part according to the materials of the protocol of the 12th Session of the Comprehensive Working Group (KRG) on the CEMA OKP [Unionwide Classification System for Industrial and Agricultural Products].

The dynamics of changes to the system classification part during 1984-1985 stemming from directives to add, delete or revise (according to each change list) is shown in the figure.

The total number of changes from the directives and the system classes to which the changes were made are shown in the table.

The nature of the diagram of the distribution of changes from the directives showed:
the least number of changes occurred in the first half of 1984 after the classification system manuscript was given to the publisher, which is

System change issue number, year, quarter	System classes to which changes were made	Adds	Deletes	Revisions	Total
38 (1984, I)	3I,47,5I,9I	49	4	II6	I69
39 (1984, II)	2I,22,23,24,25,3I,33,36,52,94, 97	I29	II	20	I60
40 (1984, III)	33,34,38,39,52,84,93,96	205	I07	I57	469
4I (1984, IY)	I7,23,3I,34,36,39,42,48,5I,54, 8I,82,83,87,89,90,9I,96	I28	232	95	455
	Total	5II	354	388	I253
42 (1985, I)	I7,2I,22,23,3I,33,34,36,37,44, 5I,57,58,64,65,66,68,69,75,85, 87,93,96	86	I27	82	295
43 (1985, I)	I7,I9,2I,24,3I,33,34,85,9I,93, 95,96	39	220	60	3I9
44 (1985, II)	I4,I7,I8,2I,24,25,3I,36,47,53, 54,90	I07	I50	33	290
45 (1985, III)	I7,I9,2I,22,23,24,36,47,55	90	I	I3	I04
46 (1985, IY)	I7,I9,2I,23,25,3I,34,36,4I,46, 48,5I,54,56	I98	67	64	329
	Total	520	565	252	I337

explained by the great effort on revising the items in the classification system, made by GNITsVOK [Main Scientific Research Center for Maintenance of Unionwide Classification Systems] and lead organizations during preparation of it;

the highest number of changes were made in the third and fourth quarters of 1984; this was due to the addition of new and previously uncoded products to the system classification part file, to bringing the group titles in the system classification part in line with the group titles in the CEMA system classification part, and to the deletion of groups in accordance with the limitation requirement of the system classification part in the fourth and fifth positions of the code;

in 1985 was made large number of changes from results of 12th session of KRG in connection with the limitation of the system classification part.

The system classification part now has 55,112 items.

Keeping the system classification part up to date allows distributing collections of changes to the system classification part to subscribers quarterly, which will make it possible to solve problems of planning, pricing, standardization, supply of materials and equipment and sales of products by using the codes in the system classification part in interdepartmental documents.

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EXPERIENCE OF AUTOMATED MAINTENANCE OF SECTOR TECHNOLOGICAL CLASSIFICATION SYSTEMS

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 18-21

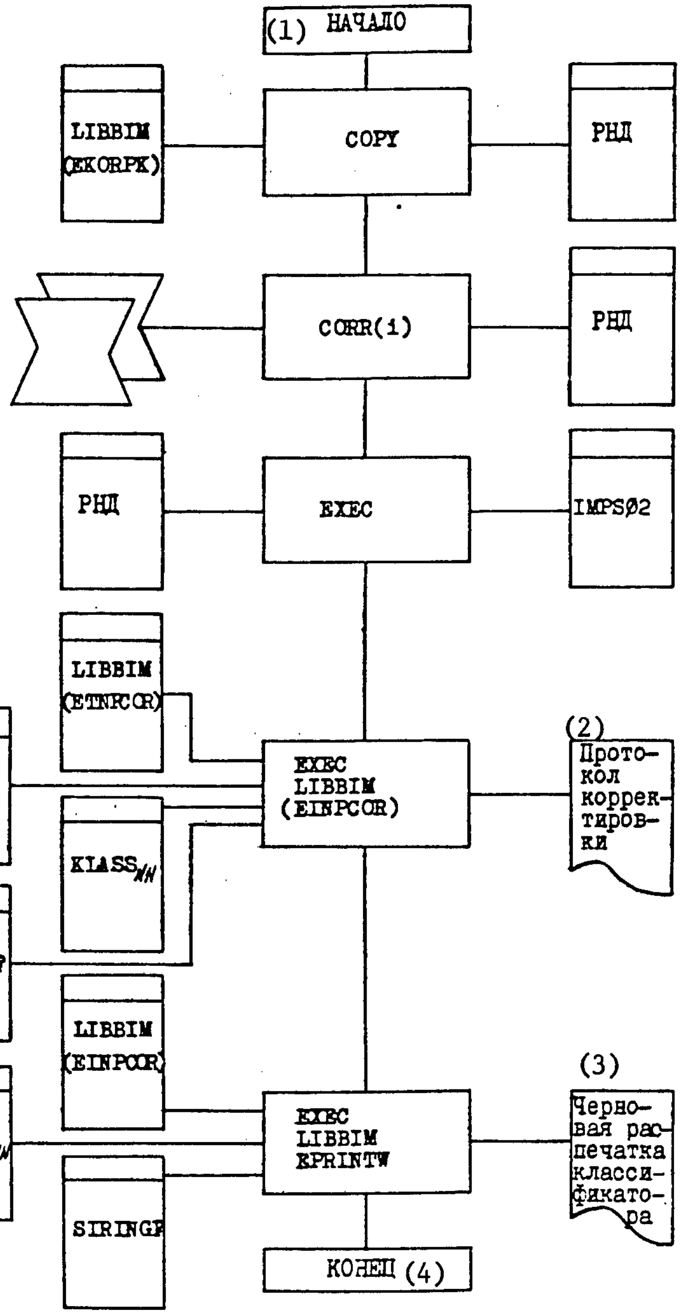
[Article by V. V. Barinov, L. P. Reimzova and V. D. Akulina]

[Text] Ensuring high rates of industrial development is closely related to automating technical and engineering work and, in particular, the problems of tooling up for production (TPP). Solving this problem presupposes the availability of classification systems of information which is processed by using computers. To solve problems in tooling up for production, technological classification systems of parts, assembly units and manufacturing operations are used [1, 2].

The technological classification systems in effect in a sector allow structuring information on the technology being used and the objects of production. They are intended as the information base for automating a number of operations in tooling up for production. This allows reducing the cycle of tooling up for production of new items thanks to raising the efficiency of performing process design analysis of items and automating the design of manufacturing processes by individual types of production. Using classification systems allows employing common (standardized) terminology.

Analysis of the experience of using sector technological classification systems has shown the necessity of continuous maintenance of them. This is caused by the natural evolution of industry: by the cancellation of some operations and the emergence or modernization of others. Information on changes in the composition and content of manufacturing operations used in enterprises goes into the base organization for classification and coding which issues notices on the change in classification systems of technological information.

In connection with speeding up the rates of industrial development, demands are increasing for promptness in updating (maintaining) the information bank in sector technological classification systems and the output of information on changes to subscribing enterprises. Therefore, the automated system for maintenance of sector technological classification systems (ASVOTK) as part of the sector automated system for maintenance of classification systems (OASVK) was created as the base organization for classification and coding.



Classification system maintenance

Key:
1. Start
2. Transaction log
3. Draft printout of classification system
4. End

Organizing the process of maintaining technological classification systems by using automation consists in recording the input data (during loading of the information base and updating) on perforated cards, magnetic tapes and magnetic disks. The classification system information is completely generated on magnetic media with retention of the numeration of its tables. The magnetic tape with the classification systems recorded is stored in the base organization for classification and coding which can send copies of the magnetic tape to a using enterprise for operation and printing. The operating documentation allows a using enterprise to:
print out any classification system;
make changes in accordance with a change notice (replace a table or record, hold a reserve group, delete a record); and
use the information in the classification systems in solving the problems in an automated system for tooling up for production.

Solving the problem of maintaining classification systems (see the figure) consists in the sequential implementation of the following procedures:
COPY - the needed sections (EKORPK) of the document to be updated are called from the classification systems library (LIBBIM) and the PHD file is created;
CORR - the new data is input into the PHD file;
EXEC - specifications are transferred from the PHD to the IMPS02 data file;
EXEC LIBBIM (EINPCOR) - the set of updated data is input into the classification systems library with an accounting of the files of pages ($KLASS_{NN}$) and the file of relations (STRINGA);

EXEC LIBBIM (EPRINIW) [as published] - the needed classification system is printed.

The classification systems are maintained on a Unified System computer equipped with 512K or more bytes of memory and a YeS-5061 or YeS-5066 NMD [disk storage unit].

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2. "Tekhnologicheskiy klassifikator detaley mashinostroyeniya i priborostroyeniya." [Technological Classification System for Parts in Machine Building and Instrument Making], Moscow, Izd-vo standartov, 1983.

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SECTOR AUTOMATED SYSTEM FOR CENTRALIZED MAINTENANCE OF CLASSIFICATION SYSTEMS FOR USSR MINISTRY OF EDUCATION

Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 9, Sep 86 pp 21-26

[Article by A. L. Litvina (NII ShOTSO [Scientific Research Institute of School Equipment and Training Hardware]) and B. V. Perlov (GIVTs APN SSSR [Main Information and Computing Center, USSR Academy of Pedagogical Sciences])]

[Text] The Sector Automated System for Centralized Maintenance of Classification Systems (OASTsVK MP SSSR) has been put into industrial operation in the USSR Ministry of Education.

This system was developed in the sectors independently of each other. This led to differences in system structure not only in composition of problems solved but also in software and data base organization and management.

Development of this system in the USSR Ministry of Education was begun at a rapid pace in the 11th Five-Year Plan. A number of problems associated with development of system structure, definition of purpose of its elements, distribution of functions, generation of composition of problems, organization of interaction, development of software and data base organization and management, improvement of hardware base, assessment of prospects of development and others had to be solved. Questions on the composition of problems to be solved by the system at the present time stem from reform of the general educational school, introduction of universal computer literacy, extensive equipping of schools with electronic computing hardware, purposeful vocational training of teachers and the general educational school having to become a major element in training highly skilled cadres for all sectors in the national economy.

The number of computer centers and subsystems in ASU [automated management systems] is being continuously increased in the USSR Ministry of Education system. The administrative staff in the ministry, organizations and institutions subordinate to it and the Academy of Pedagogical Sciences have also become interested and are participating in the effort on maintenance of classification systems. Sector automated management system interaction with automated management systems in the USSR Gosplan [State Planning Committee], Gosstandart [State Standards Committee], the USSR TsSU [Central Statistical

Administration], with the main (information) computer centers in the ministries of education (public education) in the union republics, with administrative agencies in the ministries and departments and manufacturers of school equipment has been expanded considerably in recent years. For example, documents on planning and distribution of visual and instructional materials and training equipment are prepared by using computers for dozens of ministries and departments, and for hundreds of enterprises and organizations. And under the conditions of scientific and technical progress, a further increase in the number of them is the trend. The growth in the scale of use of computers is causing continuous demand for improvement in the standard system for classification and coding of information, and the standardization of forms of input and output documents.

At this stage of development, the USSR Ministry of Education Sector Automated System for Centralized Maintenance of Classification Systems is the aggregate of the agencies, methods and means facilitating automated development and maintenance of classification systems in a sound (current) status and providing information services to users. Being a component of the automated system for maintenance of unionwide classification systems, it serves at the same time as a subsystem in the sector automated management system.

As applied to the USSR Ministry of Education, there are three levels in the structure of the automated system for maintenance of unionwide classification systems: statewide, sectorial and republic. The second and third levels are directly included in the structure of the USSR Ministry of Education Sector Automated System for Centralized Maintenance of Classification Systems.

At the sector level in the latter system are the:

Administration for Information Science and Electronic Computing Hardware in the USSR Ministry of Education - the agency exercising general direction and coordination of efforts on developing, introducing and improving the Sector Automated System for Centralized Maintenance of Classification Systems in the sector of education;

Scientific Research Institute of School Equipment and Training Hardware (NII ShOTSO), USSR APN [Academy of Pedagogical Sciences] - the lead organization on unionwide classification systems for economic and technical information (OK TEI) and development of subclass 96 6 "School Equipment" in the Unionwide Classification System for Industrial and Agricultural Products (OKP), which is assigned to the sector of education;

Main Computing and Information Center of the USSR Ministry of Education - the organization and coexecutive responsible for automated maintenance of classification systems for economic and technical information;

and the lead organizations for development of sector classification systems, designated by orders of the USSR Ministry of Education.

On the republic level, the Sector Automated System for Centralized Maintenance of Classification Systems includes the lead organizations designated by

the ministries of education (public education) of the union republics and the main (information) computing centers (GVTs or IVTs) of the ministries of education in the union republics.

The sector system is being developed using the hardware base of the USSR Ministry of Education Main information and Computing Center, and the main computer centers and information and computing centers in the union republics.

The institutions and organizations who are the subscribers to the sector system are assigned to the appropriate lead organizations by affiliation. Subdivisions of the USSR Ministry of Education and USSR Academy of Pedagogical Sciences and the institutions subordinate to them are assigned to elements on the second level of the sector system. Subdivisions of the ministries of education of the union republics and institutions subordinate to them are assigned to elements on the republic level in the sector system. In addition, republic level elements in the sector system are subscribers to sector level elements in the sector system. At the present time in the sector system, developed by the Scientific Research Institute of School Equipment and Training Hardware (NII ShOTSO), USSR APN [Academy of Pedagogical Sciences], together with the USSR Ministry of Education Main Computing and information Center, the solution to the following complexes of problems has been provided for:

development and automated maintenance of standards developed in the USSR Ministry of Education for subclass 96 6 of the Unionwide Classification System for Industrial and Agricultural Products and the sector classification systems needed for planning and distribution of equipment used in general educational schools (Standards of Classification Systems Complex);

generation and maintenance of reference copies of classification systems (sections of them) developed in other USSR ministries and departments, the information of which is used in the USSR Ministry of Education (Reference Copies of Classification Systems Complex);

development and automated maintenance of reference information files (Reference Information Bank Complex);

development and operation of facilities for providing information services to subscribers (User Services Complex);

development and automated maintenance of a library of algorithms, programs and data sets (Library Complex); and

implementation of comparative checking, protection and recovery of information (Protection and Recovery Complex).

The following problems are solved in the Standards of Classification Systems complex: development and transfer, for centralized maintenance, of standards of classification systems and files of changes to them, prepared on magnetic tapes and as paper documents; creation of files of changes to classification systems (by sections for item deletions, changes and additions) and entry of them into the appropriate standards on machine media of information; updating

of classification system standards prepared as paper documents; and implementation of input format checking. The capability of algorithmic conversion of information from the form of representation on machine media to the form of representation as a paper document (a document prepared in format A 4 in accordance with GOST [State Standard] 7.3-77 on sheets of stationery with a size of 210 x 297 mm) has been implemented in this complex. With algorithmic conversion of the formats, errors which occur in retyping on a typewriter are prevented, the time needed to adjust the standards is cut in half, and the time needed to generate classification systems is reduced considerably.

Efforts on computer-aided design of classification systems are underway within the scope of the Standards of Classification Systems complex. Although efforts in this direction are still in the initial stage, automated preparation of designs of the sector classification systems "Academic Subjects in the General Educational School," "Academic Subjects and Courses in the General Educational School," and "Academic Topics in the General Educational School" has already allowed efficient preparation, duplication and distribution for comments of the first editions of them.

The Reference Copies of Classification Systems complex includes problems associated with receiving classification systems and changes to them from the GNITsVOK [Main Scientific Research Center for Maintenance of Unionwide Classification Systems] and lead organizations for the unionwide classification systems for economic and technical information of other ministries and departments. Access to the information needed by interested organizations and institutions in the sector is provided in the USSR Ministry of Education Sector Automated System for Centralized Maintenance of Classification Systems. A feature of this complex: not all the information on classification systems is stored in the sector system for the USSR Ministry of Education, but only the fragments of those required for use in the sector. This allows considerable savings in the machine memory needed to ensure functioning of the numerous subsystems in the sector automated management system.

Problems solved in the Reference Information Bank complex are: development and maintenance of subject and alphabetical indices to objects being classified, topic files (for example, lists of products distributed to general educational schools in the country), auxiliary and terminological files, and recoding tables of codes of local classification systems to codes of unionwide classification systems. Using computers to prepare alphabetic and subject indices to classification systems saves considerable time and labor.

The User Services complex includes the following problems: automated retrospective retrieval of information by codes, ranges of codes, titles of products and groups of key words; servicing of users for one-time queries and in the mode of selective distribution of information; maintenance of lists of subscribers and their queries; generation of documents on changes to classification systems and refinement of them for users; circulation of classification systems recorded on magnetic tapes and supply of them to system subscribers. Specialized algorithms and programs were developed for this complex. It is advisable in future to use algorithms and programs from document information retrieval systems in operation. In the process, standard software

should be used for all levels in the automated system for maintenance of unionwide classification systems.

The Library and Protection and Recovery complexes are now separate, but it is planned to combine them in the near future. The following problems are solved in them: generation and storage, on magnetic tapes, of the library of the standards used in the sector system, reference copies and changes to classification systems, algorithms, programs, and the library for the reference information bank; comparative checking of information; protection of data against unauthorized access; and recovery of information in emergency situations. The availability of the algorithm for comparative checking of information allows using a display to immediately correct information in event errors are detected in a working file and to subsequently (after comparison of working files to the standards) identify all changes made to the file for making a decision on the necessity of making definitive changes to a classification system.

Introducing the USSR Ministry of Education Sector Automated System for Centralized Maintenance of Classification Systems into operation will make it possible to more efficiently solve the problems of automated maintenance of classification systems of major national economic value today.

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YOUR ASSISTANT -- THE PROGRAMMABLE MICROCALCULATOR

Moscow TEKHNIKA V SELSKOM KHOZYAYSTVE in Russian No 12, Dec 86, pp 20-21, 21-24, 25-26

[Series of articles under the "Electrification" and "Microelectronics -- into Agriculture" rubrics: "Programmable Microcalculators", by G. T. Kleyman; "The Programmable Microcalculator at Work", by O. A. Subbotin; and "Using Programmable Microcalculators for Cost Analysis", by V. T. Nadykto and P. S. Savenko. First paragraph is italicized text; second paragraph is editorial introduction in boldface.]

[Text] /To rapidly increase the extent to which modern, high-speed computers of all types are used./

WITH THIS SERIES OF ARTICLES, THE EDITORS HOPE TO ACQUAINT THE READER WITH GUIDELINES FOR USING PROGRAMMABLE MICROCALCULATORS TO PERFORM ANALYSES IN THE AREA OF AGRICULTURAL PRODUCTION. THE PROGRAMMING EXAMPLES PRESENTED HEREIN WERE WRITTEN FOR THE WIDELY USED "ELEKTRONIKA BZ-34". THE EDITORS WELCOME COMMENTS ON THE ARTICLES FROM READERS.

UDC 651.2:681.3.004.11

PROGRAMMABLE MICROCALCULATORS

[Article by G. T. Kleyman, engineer]

A little more than 10 years has passed since this country produced the first "Elektronika BZ-04" microcalculator, on which only four arithmetic operations could be performed. More intricate engineering microcalculators (IMKs), as they were called, first appeared in 1977 and, by 1980, they were being widely used. In addition to arithmetic operations, they could perform trigonometric, exponential, and logarithmic functions, and functions with parentheses. The latest IMKs can even determine the statistical characteristics of a set of numbers. Thus, scientists and technicians have acquired a tool that can be used to mechanize simple, yet laborious and time-consuming calculations. It should be emphasized that, although IMKs are clearly inferior to computers in regard to speed, memory, and the complexity of the problems which they can solve, they are very popular due to their low cost, portability, ease of use,

the ability to run on battery power, a feature that is especially important to agricultural professionals.

At the same time, the IMK has a serious drawback -- the inability to automate calculations, i.e., to perform them according to a pre-written program.

The programmable calculators (PMKs) that have come out in the eighties overcome this problem. Structurally, they consist of a conventional IMK and a programming unit that contains a memory for storing programs, a working memory for storing constants or intermediate calculations, and keys for the programming commands.

The first mass-produced PMK made in the Soviet Union, the "Elektronika BZ-21", had a programming memory of 60 operations (steps) and a working memory consisting of seven registers, giving it the ability to read and write a random combination of up to seven numbers.

The second-generation PMK is much more versatile and easy to use. The most common model of this series is the "Elektronika BZ-34".

The later-model PMK "Elektronika BZ-54" features an easier-to-use design, and it requires less electricity than previous models because it incorporates a liquid-crystal display. Designed for professional use, the MK-56 has large keys, a big display, and mains power supply.

All of these PMKs have identical programming and calculating capabilities: the programming memory has 98 steps, the working memory -- 14 registers. In addition, they have four registers put together as a ring (known as a stack).

The most sophisticated of the second generation PMKs is the newcomer "Elektronika MK-61", which has a 105-step programming memory, 15 registers, and a stack with five registers, as well as auxilliary function keys for integer segregation, the generation of random numbers from zero to one, and the basic logical operations "AND", "OR", "exclusive OR", and inversion.

The PMK is so easy to program that one can master the process with little or no help in 10 to 15 hours of concentrated study of the instructions and working with the PMK. The best way to expand the program base is to develop programs for the specialized problems of the user's occupation. Normally, one acquires basic programming skills after having written and run on a PMK from five to eight programs totalling 20 to 30 steps. Confidence in one's programming ability increases while, at the same time, one acquires an interest in adapting programs to one's interests. The PMKs are powerful tools, although their main drawback -- having to load a program and check with a special procedure every time a PMK is turned on -- is beginning to be felt. When several problems requiring different programs must be solved, it becomes a nuisance that costs 50 to 60 percent of the workday.

Third-generation PMKs do not have this problem. They have a permanent re-programmable storage device (PPZU) which can store a program for at least six

months after the power has been turned off.

One such PMK is the "Elektronika MK-52", an MK-61 microcalculator expanded with a 512-step PPZU and additional keys for running it.

What does 512 steps mean? It means that, for example, 15 programs containing 30 to 35 steps apiece can be written and stored in the PMK; in other words, practically all the programs required for a particular job. Naturally, any of the programs can be called from the PPZU and input into the primary programming memory for work or modification. In the latter instance, the edited program can be stored in the PPZU.

The greatly increased versatility of the PMK "Elektronika MK-52" was obtained while retaining its other basic advantages: portability and battery-powered operation. Its dimensions are 212 by 78 by 35 mm, and it weighs 250 grams.

The PMK "Elektronika MK-49" is even more interesting to use. In addition to a primary programming memory of 98 steps, 14 registers, and a 1024-step PPZU, it has a completely new for PMKs data-collection unit with analogue sensors and output of analogue control data to any recording or display device. A PMK can query up to eight sensors having the following ranges for signal output: ±.1 V, ±1 V, ±10 V. The results of processing the sensor signals can either be displayed or, after conversion into analogue form, truncated for control purposes. The results can also be stored on hard copy from a microprinter.

PMKs provide the means to have a portable and inexpensive automated system for controlling, for example, the temperature in a hothouse. The PMK would query eight thermal sensors placed in various places, average the readings and, depending on pre-programmed settings stored in the memory, release a signal for controlling the heating process. In contrast to conventional automated equipment that is hard-programmed, the PMK programs can easily be changed by the operator at any time and can be modified depending on the temperature conditions inside the greenhouse.

The basic principles for writing PMK programs are practically the same as those for large computers and incorporate these basic steps: data input; output of results; sequential performance of given operations; transfer of control up and down the list of operations (unconditional transfers); transfers in the event a given condition is fulfilled (conditional transfers); transition to sub-programs; and organization of cycles of calculations.

Each command of a program is input by the corresponding key, so the options of such a simple method of programming are fundamentally limited. In addition, a serious drawback of the PMK is the relatively slow speed at which it performs calculations. For example, a 20 to 30-step program requires 10 to 15 seconds to do the calculations.

At the same time, it is once again necessary to emphasize that the capabilities of modern PMKs are quite sufficient for solving practically all types of calculation problems encountered in the day-to-day work of the agricultural specialist. Moreover, the potential exists to master completely new types of

problems. Thus, for example, knowing the interrelationships among the conditions under which a grain combine operates (type of crop being harvested, average yield, humidity, and the chaff concentration) and operating data for the machine (revolutions of the threshing drum, forward and rear clearances, etc.), one can calculate an adjustment for the combine that is optimal from the standpoint of minimal losses combined with the highest possible productivity.

Each specialist on the job should determine PMK applications suitable for his or her work and develop programs to solve the problems that are revealed.

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THE PROGRAMMABLE MICROCALCULATOR AT WORK

Moscow TEKHNIKA V SELSKOM KHOZYAYSTVE in Russian No 12, Dec 86, pp 21-24

[Article by O. A. Subotin, engineer, from a series of articles entitled "Your Assistant -- the Programmable Microcalculator" published under the "Electrification" and "Microelectronics -- into Agriculture" rubrics.]

[Text] The versatility of Soviet-made programmable microcalculators (PMKs) means that they can be used for many different types of calculations. The low cost, reliability, and adequate calculating speed of "pocket" calculators are, to a large extent, helpful in this regard.

This article shows how to use programs to perform economic analyses in agricultural production and to perform statistical analyses. A program that will help untrained readers learn how to use programmable microcalculators will be demonstrated before going on to the complex programs.

Many readers are familiar with "perpetual" calenders which can be used to determine a particular day of the week. This somewhat laborious operation can be done quickly on an "Elektronika BZ-34" PMK using the "Calendar" program (Table 1). In this program, the day of the week being sought is assigned a number from 0 to 6 (0 for Sunday, 1 for Monday, 2 for Tuesday, and so forth). To make it easier to learn the calculations being programmed, Table 1 shows all of the calculator's display readings corresponding to each "step" of the program.

After the microcalculator is turned on and put into the "program" mode (by depressing the keys "B/O", "F", and "PRG"), the numerals 00 appear to the right on the display. These numerals indicate the address that will be used to locate the input command, i.e., the number of the cell in the programming memory that is "obliged" to store the command being input. Thus, in the "Calendar" program, the initial command (key "XY") is "registered" at the address 00. Immediately after this command is input, the numerals 01 appear in the very same place on the display, showing the address of the next command, and so on. While this is going on, the left side of the display shows the code of the command that has just been input, in other words, its "name" in the language of the PMK. The code ("name") of a command can be used to verify that it has been "registered" in agreement with the text of the program. Between the code of the command that has just been input and the address of the next command to

be input, the display lights up with the codes of the two commands previously input. One must remember that, when loading a program, there is no one-to-one correspondence between each pressing of a key and each command. Often, a command requires pressing at least two keys.

A Таблица 1*

a Световой индикатор				b Команда	a Световой индикатор				b Команда
c код введенной команды	d коды двух предыдущих команд		e адрес вводимой команды**	f нажимаемые клавиши	c код введенной команды	d коды двух предыдущих команд		e адрес вводимой команды	f нажимаемые клавиши
			00	$\overleftarrow{XY}$	42	53	62	26	+
14			01	3	10	42	53	27	+
03	14		02	—	10	10	42	28	7
11	03	14	03	$F_x<0$	07	10	10	29	:
5C	11	03	04	12	13	07	10	30	↑
12	5C	11	05	$\overleftarrow{XY}$	0E	13	07	31	IIII
14	12	5C	06	1	53	0E	13	32	43
01	14	12	07	—	43	53	0E	33	—
11	01	14	08	$\overleftarrow{XY}$	11	43	53	34	7
14	11	01	09	1	07	11	43	35	+
01	14	11	10	2	12	07	11	36	1
02	01	14	11	+	01	12	07	37	.
10	02	01	12	4	0—	01	12	38	5
04	10	02	13	+	05	0—	01	39	ПП
10	04	10	14	ИП 1	53	05	0—	40	44
61	10	04	15	ПП	44	53	05	41	С/П
53	61	10	16	42	50	44	53	42	+
42	53	61	17	$\overleftarrow{XY}$	12	50	44	43	1
14	42	53	18	1	01	12	50	44	+
01	14	42	19	9	10	01	12	45	П3
09	01	14	20	ВП	43	10	01	46	F ⟳
0C	09	01	21	2	25	43	10	47	К ИП 3
02	0C	09	22	—	Г3	25	43	48	F[illegible]
11	02	0C	23	ИП 2	25	Г3	25	49	ИП 3
62	11	02	24	ПП	63	25	Г3	50	В/О
53	62	11	25	42	52	63	25		F, АВТ, В/О***

* Для перехода в режим «Программирование» нажмите клавиши: В/О, F, ПРГ.
** Программный адрес, в котором будет находиться вводимая команда.
*** Команды выхода микрокалькулятора из режима «Программирование».

A. Table 1* a. luminous display b. command c. code for command just input d. codes for two previous commands e. address of command being input** f. keys to be pressed *to switch to the "programming" mode, press the keys V/O, F, and PRG **programming address at which the command being input will be located ***command for taking the microcalculator out of the "programming" mode [Transliteration key: ИП =IP; ПП= PP; ВП =VP; С/П=S/P; П =P; К ИП = K IP; В/О =V/O; АВТ=AVT]

It is best to use the left hand to program and operate a PMK, thereby freeing the right hand for making notes. After the entire program has been loaded and the PMK has been put into the "automatic operation" mode (by pressing the keys "F", "AVT", and "V/O"), the program is checked using the control master. If

a problem is found after running the master, the codes for the commands must be used to check the text of the program against the contents of the PMK's programming memory. By hitting the keys "V/O", "F", and "PRG", the PMK is put back into the "programming" mode. Next, using the "$\overrightarrow{\text{ShG}}$" key, the entire program is "run" and verified for correct codes and address correspondence. The "$\overleftarrow{\text{ShG}}$" key is used to run the program in reverse. When a mistake is found, the corresponding address is displayed (using the "$\overrightarrow{\text{ShG}}$" and "$\overleftarrow{\text{ShG}}$" keys) and, just as if loading the program, the keys corresponding to the correct command are pressed. The keys "F", "AVT", and "V/O" are then pressed, and the master is run again. The PMK instructions require that some of the commands be paired, so corrections also have to be made in pairs. As in any endeavor, mastery of the PMK comes with practice.

Before starting a job on a PMK, the general instructions for loading a program are followed: 1. Turn on the PMK. 2. Put the PMK in the "programming" mode using the keys "V/O", "F", and "PRG" (on the right side of the display, the numerals 00 will light up, indicating the address of the initial command). 3. Load the program from the appropriate table (the sequential input of commands indicated in the program text). Codes are used to control the commands being input. These codes appear on the left side of the display. 4. Take the PMK out of the "programming" mode using the keys "F", "AVT", and "V/O".

The instructions for the "Calendar" program are as follows: 1. Follow the general instructions for loading a program. 2. Enter the number 30.6 and store it in the first register of the memory (after entering the number, press the keys "P" [for memory] and "1". In the same way, store the number 360.25 in the second memory register ("P" and "2"). These data are entered one time after the program is loaded, after which only calendar dates are input. For example, in order to find out on what day of the week the first man-made satellite was launched, the launch date (04 Oct 57) is input into the working registers of the PMK (RX, RY, RZ) in the following manner: The "4" and "↑" keys are pressed, then the keys for the number 10 and the "↑" key, then the keys for the numeral 1957, and, finally, the keys "V/O" and "S/P". In 22 seconds, the number 5 will appear in the display. This means that the satellite was launched on a Friday. The day of the week being sought (D) is determined using an expression that is accurate for the dates from 14 Feb 1918 to 28 Feb 2100:

$$D = \left|- \left\lceil \frac{d + \lfloor M \cdot 30.6 \rfloor + \lfloor G \cdot 365.25 \rfloor}{7} \right\rceil \cdot 7 - \right|$$

where:

$m > 3$; $M = m + 1$; $G = g - 1900$;

$m < 3$; $M = m + 13$; $G = g - 1901$,

where the $\lfloor\ \rfloor$ parentheses indicate that only the whole-number part of the expression is to be used, the $\lceil\ \rceil$ indicates that only fractions are to be used, and the $|-\ -|$ brackets mean to round off to the nearest whole number. The numerical values of the day, month, and year of the date in question are designated by the letters "d", "m", and "g".

For the sake of brevity, a simplified set of symbols will be used for program instructions and example descriptions. This, the notation "33→R7" means to enter the number 33 by pressing the appropriate keys and to store this number in the seventh register of the PMK's memory by pressing the keys "R" and "7". The notation "R1→R3" corresponds to the process of calling one number from the first register of the memory and storing it in the third register of the memory, using the keys "IP", "1", "P", and "3". Thus, the memory registers are represented by the letter R and an index number (R0, R5, RC, RX, and so forth).

The program shown in Table 2 was designed for calculating basic economic indicators when using tractors and other agricultural machinery. It can be used to evaluate the efficiency of a piece of equipment against either one machine or as part of a group of machinery. The program can handle almost any number of machines. During the transition to the calculation of economic indicators for the next group of machines, the basic data from the previous analysis are shifted to the registers RC and RD and can be called up for comparative analysis. In the event that a group of machinery contains several identical units, and an analysis is performed for one of them, the summation of the economic indicators can be accomplished simply by pressing the key "S/P".

Instructions: 1. Load the text of the program (Table 2) in accordance with the general instructions given earlier in this article. 2. Fill registers R1 through R5 with the necessary preliminary data for each piece of machinery constituting the core of the group: R1 -- net book value, in rubles; R2 -- depreciation expense, in percent; R3 -- zonal annual workload, in hours; R4 -- annual expense for routine maintenance and major repairs, in percent; R5 -- standard annual workload, in hours. 3. Input the shared-cost data: R6 -- overall price of fuel, including the cost of lubricants, in rubles per kilogram; R7 -- hourly fuel consumption per single operation, in kilograms per hour; R8 -- group productivity for shift operations, in hectares per hour; R9 -- standardized coefficient for the efficiency of invested capital. 4. Let the program run the calculations by pressing the keys "V/O" and "S/P" (the calculations will take 22 seconds). 5. Read the results. 6. Input into R1 through R5 the rest of the preliminary data for the other equipment in the group (see the part of instruction number 2 following the colon). 7. Proceed with the calculations by pressing the "S/P" key (the calculations will last 17 seconds). 8. Read the results. 9. Repeat steps 6 through 8 if all the preliminary data for the group has not been exhausted. 10. Repeat steps 2 through 10 to obtain the required economic data for the next group of machinery. It should be noted that the time required to perform the calculations (figures in parentheses) is provided arbitrarily, as the speed of calculations different PMKs can vary from 20 to 25 percent.

The programs shown in Tables 3 through 6 were written for statistical data processing. For a normally distributed value X, occasioned by a set of statistics (B_1, X_2, X_3,..., X_N), a programmable microcalculator can be used to estimate: -- the initial moments $\bar{X}^k=(X_1^k+X_2^k+X_3^k+...+X_N^k)/N$, where $\bar{X}=(X_1+X_2+X_3...X_N)/N$ determines the most probable value for X, which would be the mean value;

A Таблица 2*

Адрес a	Команды b	Код c	Адрес a	Команда b	Код c	Адрес a	Команда b	Код c
00	ИП А	6—	16	ИП 5	65	32	+	10
01	П С	4С	17	ПП	53	33	ПА	4—
02	ИП В	6L	18	40	40	34	F O	25
03	ПД	4Г	19	ПВ	4L	35	С/П	50
04	Cx	0Г	20	FBx	0	36	БП	51
06	ПВ	4L	21	0	00	37	14	14
06	ИП 0	60	22	ИП 2	62	38	ВП	ОС
07	ИП 6	66	23	ИП 3	63	39	2	02
08	ИП 7	67	24	ПП	53	40	:	13
09	0	12	25	38	38	41	ИП 1	61
10	+	10	26	ИП 4	64	42	0	12
11	ПП	53	27	ИП 5	65	43	ИП 8	68
12	43	43	28	ПП	53	44	:	13
13	ПА	4—	29	38	38	45	+	10
14	ИП В	6L	30	↑	0E	46	В/О	52
15	ИП 9	69	31	ИП А	6—	F.	АВТ.	В/О**

* Программное размещение искомых параметров в регистрах памяти ПМК в момент остановки работы программы после очередного этапа вычислений экономических показателей. PX — единичные расходы по технике (без стоимости топлива, смазочных материалов и оплаты обслуживающего персонала). PA — суммарные прямые эксплуатационные затраты; PY — единичные. PB — суммарные удельные капитальные вложения, помноженные на нормативный коэффициент; PC — суммарные прямые эксплуатационные затраты, РД — суммарные удельные капитальные вложении (с учетом нормативного коэффициента) по сопоставляемому комплексу машин, найденные в предыдущем расчете.

** Для вычисления приведенных затрат на единицу выполняемой работы достаточно произвести сложение соответствующих удельных и прямых экономических показателей.

Читателям, решившим воспользоваться этой программой, предлагается самим подобрать практические примеры расчета экономических показателей используемых в хозяйствах комплексов машин и поделиться удачным опытом с редакцией.

A. Table 2* a. address b. command c. code *the programmed distribution of unknown parameters in the memory registers

The PMK at the moment when the program stops running, after the stage of cost calculations. RX - unit expenditures on equipment (not including the cost of fuel, lubricants, and wages for maintenance personnel); RA - total direct operating costs; RY - cost per unit; RB - total specific capital investment, multiplied by a standardized coefficient; RC and RD - total direct operating costs and total capital investment (allowing for the standardized coefficient) for the group of machinery subject to comparative analysis (this would be the group from the preceding cost analysis).

**To calculate full operating costs per unit of work accomplished, it is sufficient to add together the appropriate cost figures.

Readers who would like to use this program are encouraged to perform practical cost analyses of the equipment used in their businesses and to share successful results with the editors of this publication.

[Transliteration key: ИП =IP; П =P; ПД=PD; ПB=PV; ПП=PP; Г=G; С/П =S/P; БП =BP; B/O=V/O; ABT=AVT]

A Таблица 3

Адрес a	Команда b	Код c	Адрес a	Команда b	Код c	Адрес a	Команда b	Код c
00	П 1	41	33	П 2	42	66	$F\sqrt{}$	21
01	Cx	0Г	34	3	03	67	П C	4C
02	П 2	42	35	x	12	68	ИП 1	61
03	П 3	43	36	ИП 9	69	69	:	13
04	П 4	44	37	x	12	70	П 9	49
05	1	01	38	ИП 6	66	71	ИП 3	6[illegible]
06	П 7	47	39	ПП	53	72	ИП 2	62
07	2	02	40	86	86	73	:	13
08	П 6	46	41	П 3	43	74	ИП 2	62
09	ИП 7	67	42	2	02	75	$F\sqrt{}$	21
10	С/П	50	43	x	12	76	П 5	45
11	П 8	48	44	+	10	77	:	13
12	ИП 1	61	45	↑	0E	78	П A	4—
13	—	11	46	+	10	79	ИП Д	6Г
14	П C	4C	47	ИП 9	69	80	ИП 7	67
15	ИП 7	67	48	x	12	81	:	13
16	ИП 6	66	49	ИП 7	67	82	$F\sqrt{}$	21
17	П 7	47	50	Fx^2	22	83	П 0	40
18	:	13	51	ИП 6	66	84	БП	51
19	П0	40	52	+	10	85	09	09
20	К ИП 6	Г6	53	ПП	53	86	ИП 9	69
21	ИП C	6C	54	86	86	87	ИП C	6C
22	ИП 7	67	55	П 4	44	88	x	12
23	:	13	56	ИП 2	62	89	П C	4C
24	П 9	49	57	Fx^2	22	90	x	12
25	ИП 1	61	58	:	13	91	К ИП 5	Г5
26	+	10	59	3	03	92	+	10
27	П 1	41	60	—	11	93	ИП 0	60
28	Cx	0Г	61	П B	4L	94	x	12
29	1	01	62	ИП 2	62	95	← XY →	14
30	П 5	45	63	ИП 0	60	96	—	11
31	ПП	53	64	:	13	97	В/О	52
32	86	86	65	П Д	4Г	--	F, АВТ, В/О	

B Таблица 4

Адрес a	Команда b	Код c	Адрес a	Команда b	Код c	Адрес a	Команда b	Код c
00	↑	0E	33	П 9	49	66	x	12
01	6	06	34	ИП 8	68	67	F Bx	0
02	П 0	40	35	:	13	68	ИП 8	68
03	Cx	0Г	36	П C	4C	69	x	12
04	К П↑	LE	37	ИП 1	61	70	БП	51
05	FL 0	5Г	38	ИП 5	65	71	11	11
06	04	04	39	x	12	72	6	06
07	F⟲	25	40	ИП 3	63	73	П 0	40
08	ПП	53	41	ИП 4	64	74	F⟲	25
09	72	72	42	x	12	75	К ИП 6	Г6
10	ИП 6	66	43	—	11	76	F⟲	25
11	С/П	50	44	ИП 5	65	77	ПП	53
12	БП	51	45	ИП 4	64	78	82	82
13	08	08	46	Fx^2	22	79	x	12
14	ИП 2	62	47	—	11	80	ПП	53
15	ИП 4	64	48	П 7	47	81	87	87
16	x	12	49	:	13	82	↑	0E
17	ИП 3	63	50	П B	4	82	$F x^2$	22
18	ИП 1	61	51	ИП 7	67	84	ПП	53
19	x	12	52	1	01	85	87	87
20	—	11	53	ИП 9	69	86	↑	0E
21	ИП 2	62	54	ИП 7	67	87	К ИП 0	Г0
22	ИП 1	61	55	:	1[illegible]	88	—	11
23	$F x^2$	22	56	П A	[illegible]	89	ИП 6	66
24	—	11	57	ИП [illegible]	6C	90	:	13
25	П 8	48	58	:	13	91	К ИП↑	ГE
26	:	13	59	$F\sqrt{}$	21	92	+	10
27	П Д	4Г	60	П 9	49	93	К П↑	LE
28	ИП 3	63	61	ИП C	6C	94	F⟲	25
29	ИП 1	61	62	x	12	95	В/О	52
30	ИП 4	64	63	П 0	40	—	F, АВТ.	В/О
31	x	12	64	$F x^2$	22			
32	—	11	65	--	11			

A. Table 3 B. Table 4 a. address b. command c. code [Transliteration key: П=P; ИП=IP; С/П=S/P; K=K; ПП=PP; Г=G; Д=D; БП=BP; В/О=V/O; АВТ=AVT]

A Таблица 5

Адрес a	Команда b	Код c	Адрес a	Команда b	Код c	Адрес a	Команда b	Код c
00	FL0	5Г	33	ИП С	6С	66	79	79
01	40	40	34	x	12	67	К ИП 0	Г0
02	С/П	50	35	ИП 7	67	68	В/О	52
03	БП	51	36	$F x^2$	22	69	К ИП 0	Г0
04	42	42	37	—	11	70	—	11
05	4	04	38	:	13	71	ИП 4	64
06	П 0	40	39	В/О	52	72	:	13
07	ИП 7	67	40	КП↑	LE	73	↑	0E
08	ПП	53	41	К БП Д	8Г	74	↑	0E
09	91	91	42	К ИП 4	Г4	75	К ИП↑	ГЕ
10	ИП 6	66	43	1	01	76	+	10
11	ИП 8	68	44	4	04	77	КП↑	LE
12	ПП	53	45	П 0	40	78	F ⟲	25
13	92	92	46	ИП 1	61	79	x	12
14	ИП 5	65	47	ПП	53	80	ИП 4	64
15	ИП 8	68	48	69	69	81	x	12
16	ИП С	6С	49	П 1	41	82	К ИП 0	Г0
17	ПП	53	50	ИП 2	62	83	+	10
18	93	93	51	ПП	53	84	↑	0E
19	ИП 5	65	52	69	69	85	ИП 4	64
20	ИП 6	66	53	П 2	42	86	:	13
21	ИП С	6С	54	ИП 3	63	87	—	11
22	ПП	53	55	ПП	53	88	К П↑	LE
23	27	27	56	69	69	89	F ⟲	25
24	ИП 6	66	57	ИП 1	61	90	В/О	52
25	ИП 5	65	58	ИП 2	62	91	ИП С	6С
26	ИП А	6—	59	ПП	53	92	ИП А	6—
27	x	12	60	79	79	93	x	12
28	$\overleftrightarrow{XY}$	14	61	ИП 2	62	94	$F\sqrt{\ }$	21
29	ИП 7	67	62	ПП	53	95	:	13
30	x	12	63	79	79	96	К П 0	L0
31	—	11	64	ИП 1	61	97	В/О	52
32	ИП А	6—	65	ПП	53	—	F, АВТ.	В/О

B Таблица 6

Адрес a	Команда b	Код c	Адрес a	Команда b	Код c	Адрес a	Команда b	Код c
00	КП↑	LE	33	ИП 9	69	66	4	04
01	FL0	5Г	34	ПП	53	67	П 0	40
02	00	00	35	57	57	68	ИП 3	63
03	С/П	50	36	ИП 5	65	69	ИП 2	62
04	БП	51	37	ИП 8	68	70	ПП	53
05	64	64	38	x	12	71	81	81
06	1	01	39	ИП 7	67	72	ИП 1	61
07	4	04	40	ИП В	6L	73	ПП	53
08	П 1	41	41	x	12	74	80	80
09	1	01	42	—	11	75	ИП 2	62
10	К ИП 1	Г1	43	ИП 5	65	76	ПП	53
11	К ИП 1	Г1	44	ИП В	6L	77	80	80
12	Fx^2	22	45	x	12	78	К ИП 0	Г0
13	—	11	46	ИП 8	68	79	К БП 0	80
14	К ИП 1	Г1	47	ИП Д	6Г	80	$\overleftrightarrow{XY}$	14
15	F ⟲	25	48	x	12	81	↑	0E
16	x	12	49	—	11	82	↑	0E
17	К П↑	LE	50	:	13	83	ПП	53
18	F Вx	0	61	В/О	52	84	88	88
19	FL0	5Г	52	4	04	85	↑	0E
20	10	10	53	П0	40	86	ПП	53
21	ИП 3	63	54	ИП 5	65	87	89	89
22	x	12	55	ИП С	6С	88	x	12
23	П 3	43	56	ИП 6	66	89	К ИП 0	Г0
24	ПП	53	57	x	12	90	—	11
25	52	52	58	—	11	91	ИП 4	64
26	ИП В	6L	59	К ИП 0	Г0	92	:	13
27	ИП 9	69	60	$F\sqrt{\ }$	21	93	К ИП↑	ГЕ
28	ИП С	6С	61	:	13	94	+	10
29	ПП	53	62	КП↑	LE	95	КП↑	LE
30	57	57	63	В/О	52	96	F ⟲	25
31	ИП 8	68	64	К ИП 4	Г4	97	В/О	52
32	ИП 6	66	65	1	01	—	F, АВТ.	В/О

A. Table 5 B. Table 6 a. address b. command c. code [Transliteration key: see transliteration key for Tables 3 and 4]

-- the central moments $M_k=\{(X_1-\bar{X})^k+(X_2-\bar{X})^k+(X_3-\bar{X})^k+\ldots+(X_N-\bar{X})^k\}/N$, where $M_2=\{(X_1-\bar{X})^2+(X_2-\bar{X})^2+(X_3-\bar{X})^2+\ldots+(X_N-\bar{X})^2\}/N$ determines the probable degree of deviation of the value of X from $\bar{X}$, i.e., the variance;

-- the standard deviation $S=\sqrt{M_2}$;

-- the unbiased variance $\sigma^2=NM_2/(N-1)$;

-- the standard deviation for the unbiased variance $\sigma=\sqrt{\sigma^2}$;

-- the standard error $\sigma_\mu=\sigma/\sqrt{N}$;

-- the coefficient of variation $K_v=\sigma/\sqrt{X}$;

-- the assymetry (A) and excess (E) characteristics: $A=M_3/\sqrt{M_2^3}$; where $M_3=\bar{X}^3-3M_2\bar{X}-\bar{X}^3$; $E=M_4/M_2^2-3$, where $M_4=\bar{X}^4-4M_3\bar{X}-6M_2\bar{X}^2-\bar{X}^4$.

When determining the characteristics of the set of X- and Y-values (X_1, X_2, $X_3\ldots,X_N$; Y_1, Y_2, $Y_3,\ldots Y_N$), and estimate if performed for:

-- the correlation moment (covariation) $R_{xy}=\overline{XY}-\bar{X}\bar{Y}$;

-- the correlation coefficient $r_{xy}=R_{xy}/S_xS_y$;

-- the parameters for the linear regression equations $Y=aX+b$, where $a=r_{xy}\sigma_y/\sigma_x$, $b=\bar{Y}-a\bar{X}$, $S^2_{y(x)}=(N-1)\sigma^2_y(1-r^2_{xy})$, $X=cY+d$, where $c=r_{xy}\sigma_x/\sigma_y$, $d=\bar{X}-c\bar{Y}$, $S_{x(y)}=(N-1)\sigma^2_x(1-r^2_{xy})$.

Estimations for the parameters in the event of a combined sample for three values are presented for the linear regression Z on X and Y: $Z=UX+VY$, where $U=(M_{2_{y^2}}R_{xz}-R_{xy}R_{yz})/D$, $D=M_{2_x}M_{2_y}-R_{xy}R_{xy}$, $V=(M_{2_x}R_{yz}-R_{xy}R_{xz})/D$,

$(S^2_{z(x,y)}=M_{2_z}-UR_{xr}-VR_{yz})$.

In all of the other programs that will be presented in this article, the support algorithm assumes the form of an algorithm for a running estimate of the mean $\bar{X}_i=\bar{X}_j+(X_i-X_j)/i$, with $j=i-1$, $i=1, 2, 3 \ldots, N$. This substantially reduces operational error and practically eliminates constraints on the length of the initial mass of statistics and the size of the numbers themselves.

Table 3 contains a program for the running estimation of the parameters: $\bar{X}$, M_2, M_3, M , K_v, A, E, . . S, σ^2.

Instructions: Load the program -- Table 3 (see the general instructions). 2. The first keys to be pressed are "V/O", X_1, and "S/P" (calculation takes three seconds, the display reads i=1). 3. X_2, "S/P" (calculation -- 35 seconds, i=2). 4. X_3, "S/P" (calculation -- 35 seconds, i=3) and so forth until the value sought for i or until i=N. 5. Read the results: RO--R6, RA--RD (remember that $X_1 \neq X_2$).

Example: "V/O", 4, "S/P" (i=1); 9, "S/P" (i=2); 13, "S/P" (i=3); 15, "S/P"

(i=4); 27 "S/P" (i=5). Read the results: R1($\bar{X}$)13.6; R2(M_2)59.04; R3(M_3) 285.312; R4(M_4)8237.394; R5(S)7.684; R6(N+1)6; R0(σ_μ)3.84; RA(A)0.6289; RB(E) 0.6368; RC(σ)8.59; RD(σ^2)73.8; R9(K_v)0.6317.

The next program (Table 4) was designed to find the the cross correlation and reciprocal regression of the X- and Y-values through the parameters: $\bar{X}$, $\bar{Y}$, $\overline{XX}$, $\overline{YY}$, $\overline{XY}$, M_{2_x}, M_{2_y}, σ_y/σ_x, r_{xy}, a, b, c, d, $S^2_{y(x)}$, $S^2_{x(y)}$.

Instructions: Load the program from Table 4 (see the general instructions). 2. The first keys to be pressed are "V/O", Y_1, "↑", X_1, "S/P" (calculation time -- 28 seconds; the display reads i=1). 3. Y_2, "↑", X_2, "S/P" (i=2). 4. Y_3, "↑", X_3, "S/P" (i=3). 5. To find the intermediate unknown parameters, press "$\overrightarrow{\text{ShG}}$" and "S/P" (calculation time -- 22 seconds). 6. Read the results: RX, RY, RO--RD. 7. Continue inputting the initial data: Y_4, "↑", X_4, "S/P" (calculation time -- 28 seconds, i=4) and so on until the next value sought for i or until i=N.

Example: "V/O", 1, "↑", 6, "S/P" (i=1); 1, "↑", 3, "S/P" (i=2); 6, "↑", 4, "S/P" (i=3). "$\overrightarrow{\text{ShG}}$", "S/P" -- read the results: PX($S^2_{x(y)}$)1.5; R0(r_{xy})-0.189; R1($\bar{Y}$)2.667; R2($\overline{YY}$)12.67; R3($\overline{XY}$)11; R4($\bar{X}$)4.333; R5($\overline{XX}$)20.33; R6(i)3; R7(M_{2_x}) 1.556; R8(M_{2_y})5.556; R9(σ_y/σ_x)1.89; RA(a)--0.357; RB(b)4.124; RC(c)--0.1; RD (d)4.6.

To determine the statistical description of a set of X-, Y-, and Z values, the program shown in Table 5 can be used. In this program, the necessary calculations are performed using the formulas for the empirical linear regression for Z on the X- and Y-values. These formulas were presented earlier in the text. In particular, the coefficients U and V for the equation for linear regression can be determined by means of the corresponding correlation coefficients, the calculation of which is incorporated into the program.

Note the fundamental property of U and V coefficients calculated in this manner: their numerical values do not depend on the scale in which the initial values for X, Y, and Z are given. The program can perform a running estimate of the following parameters: $\bar{X}$, $\bar{Y}$, $\bar{Z}$, M_{2_x}, M_{2_y}, M_{2_z}, R_{xz}, R_{yz}, R_{xy}, r_{xz}, r_{yz}, r_{xy}, U, and V.

Instructions: 1. Load the program from Table 5.(see the general instructions). 2. The first keys to be pressed are "V/O", 14→P0 "Sx", "S/P" (the automatic "setting to zero" of the memory registers of the PMK takes place at this time): 0→R1--Rd; the procedure lasts 18 seconds; the display reads i=0). 3. X_1→R1, Y_1→R2, Z_1→R3, "S/P" (calculation time -- 53 seconds, i=1). 4. X_2-R1, Y_2-R2, Z_2-R3, "S/P" (i=2). 5. X_3-R1, Y_3-R2, Z_3-R3, "S/P" (i=3). 6. To obtain the intermediate unknown parameters, press "$\overrightarrow{\text{ShG}}$" and "S/P" (calculation time -- 22 seconds. 7. Read the results: RX, RY, RO--RD.

8. Continue inputting the initial data. : X_4→R1, Y_4→R2, Z_4→R3, "S/P" and so forth until the next value sought for i or until i=N.

Example: "V/O", 14→P0, "Sx", "S/P" (i=0); -0.1→R1, -0.5→R2, -0.6→R3, "S/P" (i=1); -6.2→R1, -0.1→R2, -0.5→R3, "S/P" (i=2); 5.1→R1, 8.5→R2, 8.3→R3, "S/P" (i=3); 1→R1, 6.1→R2, 5,8→R3, "S/P" (i=4). "$\overrightarrow{\text{ShG}}$", "S/P". Read the results: RX, R0(U)0.4668; RY, RZ, RT(V)0.9619; R1(r_{xy})0.8228; R2(r_{yz})0.9996; R3(r_{xy}) 0.8061; R4(i)4; R5(R_{xz})12.985; R6(R_{yz})15.195; R7(R_{xy})12.705; R8(M_{2_z})15.2225; R9($\bar{Z}$)3.25; RA(M_{2_y})15.18; RB($\bar{Y}$)3.5; RC(M_{2_x})16.3625; RD($\bar{X}$)-0.05.

The difficulties involved in calculation the ratio of difference values used when estimating the different constants of an equilibrium are well known:

K_r=(Z-X)/Y-Z),

where Z is the mean value of the parameters, and X and Y are the parameters of the recessive and dominant forms of the equilibrium. In the case of a linear dependence of Z on Xand Y (a correlation close to one), the value for the K_r ratio can be found on the basis of computed statistical parameters using the following expression:

$K_r=(\overline{XY}\ \overline{XZ}-\overline{XX}\ \overline{YZ})/(\overline{YX}\ \overline{YZ}-\overline{YY}\ \overline{XZ})$,

which is incorporated into the program shown in Table 6.

In this program, along with the statistics used to calculate K_r, the appropriate correlation coefficients are used to estimate the cross correlation between the initial values.

The program can perform a running estimate of the following parameters: $\bar{X}$, $\bar{Y}$, $\bar{Z}$, $\overline{XX}$, $\overline{YY}$, $\overline{ZZ}$, $\overline{XZ}$, $\overline{YZ}$, $\overline{XY}$, r_{xz}, r_{yz}, r_{xy}, and K_r.

Instructions: 1. Load the program from Table 6 (see the general instructions). 2. The first keys to be pressed are "V/O", 13 R0, "Sx", "S/P" (memory registers automatically set to zero): 0→R1--RD (calculation time -- 11 seconds, i=0). 3. X_1→R1, Y_1→R2, Z_1→R3, "S/P" (calculation time -- 52 seconds, i=1). 4. X_2→R1, Y_2→R2, Z_2→R3, "S/P" (i=2). 5. X_3→R1, Y_3→R2, Z_3→R3, "S/P" (i=3). 6. To obtain the intermediate unknown parameters, press "$\overrightarrow{\text{ShG}}$" and "S/P" (calculation time -- 36 seconds). 7. Read the results: RX, R1--RD. 8. Continue inputting the initial data: X_4→R1, Y_4→R2, Z_4→R3, "S/P" and so forth until the value sought for i or until i=N.

Example: "V/O", 13→R0, "Sx", "S/P" (i=0): -3.8→R1, 1.9→R2, 1.4→R3, "S/P" (i=1); -1.2→R1, 5.7→R2, 5.3→R3, "S/P" (i=2); 38.6→R1, 45.6→R2, 45.5→R3, "S/P" (i=3). "$\overrightarrow{\text{ShG}}$", "S/P". Read the results: RX(K_r)12.179; R1(r_{xz})0.99 968 175;

R2(r_{yz})0.99 999 903; R3(r_{xy})0.99971592; R4(i)3; R5($\overline{XY}$)582.033; R6($\bar{X}$)11.2; R7 ($\overline{XX}$)501.947; R8($\overline{XZ}$)581.54; R9($\bar{Z}$)17.4; RA($\overline{ZZ}$)700.1; RB($\overline{YZ}$)702.557; RC(17.733; RD($\overline{YY}$)705.153.

The use of a PMK and its software substantially reduces the time spent to perform calculations.

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USING A PROGRAMMABLE MICROCALCULATOR FOR COST ANALYSIS

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[Article by V. T. Nadykto and P. S. Savenko, engineers, the southern department of the Ukrainian Scientific and Research Institute for the Mechanization and Electrification of Agriculture, from a series of articles entitled "Your Assistant -- the Programmable Microcalculator" published under the "Electrification" and "Microelectronics -- into Agriculture" rubrics.]

[Text] The selection of an optimal combination of agricultural machinery, or MTA [literally, machine-tractor aggregate], is done by comparing full operating costs per unit of work accomplished, whereas the selection of a set of machinery for an industrial process is based on similar costs per unit of output. Because these costs can be calculated for individual makes of tractors and other agricultural machinery and equipment, as well as for MTAs, it is possible to perform a cost analysis of agricultural machinery and equipment and to choose the most efficient individual units or MTAs for the job at hand.

Full operating costs per unit of work accomplished consist of the sum of direct operating costs plus specific capital investment multiplied by a standardized coefficient.

The analytical formula for determining full operating costs assumes the following form:

$$П = \frac{1}{W_{см}} \sum_{p=1}^{k} С_p Л_p + \frac{1}{100W_{см}} \sum_{i=1}^{m} \frac{Б_i a_i}{T_{зон.i}} + \frac{1}{100W_{см}} \sum_{i=1}^{m} \frac{Б_i b_i}{T_{нi}} + \frac{GЦ}{W_{см}} + \frac{E}{W_{см}} \sum_{i=1}^{m} \frac{Б_i}{T_{нi}}, \qquad (1)$$

($П$ stands for full operating costs)

where W_{cm} is the productivity of an MTA per hour of shift time, in hectares per hour; L_r is the number of maintenance personnel in each wage category, in persons; S_r is the hourly wages for maintenance personnel per wage category, in rubles per hour, k is the number of categories in the wage scale; B_i is

the book value of i-tractor or i-agricultural machine in the MTA, in rubles; a_i is the depreciation expense for i-agricultural machine in the MTA, expressed as a percentage; $T_{zon\ i}$ is the annual zonal workload for i-agricultural machine in the MTA, in hours; b_i is the annual expense for major repairs and routine maintenance for i-agricultural machine in the MTA, as a percentage; T_{ni} is the standardized annual workload of i-agricultural machine in the MTA, in hours; m is the number of machines (including tractors) in the MTA; G is the hourly consumption of fuel by a tractor for each specific operation, in kilograms per hour; Ts is the total cost of fuel and lubricants associated with one kilogram of basic fuel, in rubles per kilogram; and E is the standardized coefficient for the efficiency of capital investment, expressed as E=0.15.

The calculation of full operating costs using formula (1) requires a great deal of time.

The calculation time can be substantially reduced by using a BZ-34 programmable microcalculator with a special program based on formula (1). In order to formulate a program for calculating full operating costs for a two-unit MTA (a tractor and another piece of agricultural equipment) maintained and serviced by one mechanic, formula (1) is reduced to the following form:

$$\Pi' = \left\{ C_р + \frac{1}{100} \left[Б_{тр} \left(\frac{a_{тр}}{T_{зон.\,тр}} + \frac{b_{тр} + 15}{T_{н.\,тр}} \right) + Б_м \left(\frac{a_м}{T_{зон.\,м}} + \frac{b_м + 15}{T_{н.\,м}} \right) \right] + GЦ \right\} / W_{см}. \qquad (2)$$

The program is loaded into the special memory of the microcalculator by sequentially pressing the keys as shown in Table 1.

Instructions for working with the program: 1. Turn on the microcalculator by turning the tumbler switch to the right. 2. Put the microcalculator in the "Programming" mode by pressing the keys V/O, F, and PRG in that order. 3. Load the program (see the data in Table 1). 4. Put the microcalculator in the "Automatic Function" mode (press the F and AVT keys). 5. Load the numerical values of the initial data into the microcalculator's memory registers:

$C_р \to$ регистр	0	$C \to$ регистр	7
$Б_{тр} \to$ »	1	$Б_м \to$ »	8
$a_{тр} \to$ »	2	$a_м \to$ »	9
$T_{зон.\,тр} \to$ »	3	$T_{зон.\,м} \to$ »	A
$b_{тр}+15 \to$ »	4	$b_м+15 \to$ »	B
$T_{н.\,тр.} \to$ »	5	$T_{н.\,м} \to$ »	C
$Ц \to$ »	6	$W_{см} \to$ »	Д

[See the text (above) for key to symbols (tr stands for tractor, m for other types of agricultural machinery and equipment)].

To do this, the necessary digital information must be entered on the keyboard, and then the P key must be pressed, followed by the register number (for example P and 8 or P and D). 6. Run the program from the zero address (press the V/O and S/P keys). The calculation time is about 10 seconds. 7. If it is necessary to know the amount of direct operating costs, then b_{tr} is input to register 4 and b_m to register A, and the program is run (see instruction number 6). The difference between full and direct operating costs yields the specific capital investment, which is multiplied by the standardized coefficient E. To compute the full and direct operating costs for another MTA, clear the registers of the microcalculator and repeat instructions 5 through 7.

A Таблица 1

Команда a	Код b	Адрес c	Команда a	Код b	Адрес c
ИП2	62	00	ИП8	68	16
ИП3	63	01	x	12	17
÷	13	02	+	10	18
ИП4	64	03	1	01	19
ИП5	65	04	0	00	20
÷	13	05	0	00	21
+	10	06	÷	13	22
ИП1	61	07	ИП0	60	23
x	12	08	+	10	24
ИП9	69	09	ИП6	66	25
ИП A	6—	10	ИП7	67	26
÷	13	11	x	12	27
ИПB	6—	12	+	10	28
ИПC	61	13	ИПД	6Г	29
÷	13	14	÷	13	30
+	10	15	С/П	50	31

A. Table 1 a. command b. code c. address [Transliteration key: ИП =IP; Д=D; С/П =S/P.]

The limited memory of the microcalculator (14 registers) precludes the ability to perform the same type of analysis for a three-machine MTA. In this case, the analysis is done in stages:

1. Use the program to calculate the full and direct operating costs and specific capital investment for a two-machine MTA (see 1-7 of the instructions).

2. Clear the memory registers of the microcalculator and input the appropriate initial data for the third piece of machinery (or MTA) to registers 8, 9, A, B, and C. The unit of work accomplished is input to registers 3 and 5. Run the program (see instructions 6 and 7).

3. Add these results to the results of stage 1 above to obtain the full and direct operating costs and specific capital investment for the MTA as a whole.

When calculating the full and direct operating costs for an MTA with more than one mechanic, the following value is entered in register 0:

$$\sum_{p=1}^{r} Л_p \cdot C_p.$$

If, in a specific case, there are costs that formula (1) does not account for, they are added to those computed from the program.

To see that the program is being loaded correctly, the standard codes and addresses are monitored in the microcalculator's display. A control calculation is also used, whereby units instead of initial data are loaded into the microcalculator's memory registers. If the program has been correctly loaded, then the display will read 2.04 after the control calculation is run.

Here is an example of performing an analysis to determine the comparative full operating costs incurred when using two different MTAs to swathe-reap grains.

The initial data for calculating the full operating costs are provided in Table 2.

A Таблица 2

a Показатель	b Агрегат	
	c МТЗ-80+ЖВС-6	d СК-5+ЖВН-6А
$С_р$, руб/ч	1,55	1,55
$Б_{тр}$, руб.	3528	5983
$a_{тр}$, %	12,5	12,5
$Т_{зон. тр}$ ($Т_{зон. к}$), ч	1162	170
$h_{тр}+15$ ($h_к+15$), %	27+15=42	10+15=25
$Т_{н. тр.}$ ($Т_{нк}$), ч	1200	160
Ц, руб.	0,08	0,08
$С_{тр.}$ ($С_к$), кг/ч	2,6	6,02
$Б_м$, руб.	1128	829
$C_м$, %	12,5	12,5
$Т_{зон.м}$, ч	78	100
$b_м+15$, %	12+15=27	12+15=27
$Т_{нм}$, ч	90	90
$W_{см}$, га/ч	2,5	1,69

e В результате вычислений $П_1=3,42$ руб/га; $П_2=11,42$ руб/га.

A. Table 2 a. cost indicator [see p. 1 of text for key to symbols (tr stands for tractor, m for other type of agricultural machinery)] b. type of MTA c. MTZ-80+ZhVS-6 d. SK-5+ZhVN-6A e. According to the computations, $P_1=3.42$ rubles per hectare, and $P_2=11.42$ rubles per hectare. (P=full operating costs)

The analysis shows that reaping grain with an MTA consisting of an MTZ-80 tractor and a ZhVS-6 reaper yields a reduction in full operating costs of eight rubles per hectare in comparison with the CS-5 combine and the ZhVN-6A reaper.

When performing cost analyses of MTAs, labor productivity is four to six times higher when using a BZ-34 programmable microcalculator than when using a non-programmable microcalculator.

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BOOK: ELECTRONIC TRAINERS

Moscow NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA RADIOELEKTRONIKA I SVYAZ': ELEKTRONNYYE TRENAZHERY in Russian No 5, 1986 pp 1-10, 64

[Title page, annotation, introduction and table of contents from book "Electronic Trainers" in the series "What's New in Life, Science, Technology: Radio Electronics and Communications Series," Izdatelstvo "Znaniye," 46,640 copies, 64 pages. The author is a candidate of technical sciences, specializing in the field of marine trainers and computer technology, and is the author of more than 70 scientific works and 52 inventions. His scholarly interest is in the methodology of design of electronic trainers.]

Annotation

This brochure acquaints the reader with the history of the development of electronic trainers, with the principles by which they are constructed, and with the circuits from which they are built up. Pedagogical, mathematical and technical aspects of contemporary trainer design are examined. Marine, aviation, cosmonautic and other electronic trainers are considered, with descriptions of their particular features and with examples of their design and exploitation. The economic effectiveness of the use of trainers in the national economy is demonstrated.

The brochure is intended for readers interested in new trends in the development of electronics technology and in its application to the training of specialists for the national economy of the USSR.

The specialist working in the national economy as an operator of a man-machine system (SChM) must have had professional training, must possess definite knowledge and practical skills. Knowledge is gained through instruction in classrooms, through the performance of exercises, through the execution of laboratory assignments, through self-study. Skills in working with contemporary equipment and in operating and maintaining machinery and systems are gained through practical exercises on the equipment itself and through training exercises. Exercises and training sessions on real equipment are not always possible or of full value, connected as they are with the consumption of economic resources and with large material expenditures. In order to assure the acquisition of the necessary skills, to assure a thorough preparation of operators within time parameters and with minimal expenditures, specialized machines have been created, called trainers.

Trainers began to be built in our country as early as the first years of Soviet rule. Work in this direction developed in connection with the concern of the Party and government for heightening productivity and for scientific organization of labor. The central Institute of Labor (TsIT) was established by a resolution of the Council on Labor and Defense on 24 August 1921, signed by V. I. Lenin. TsIT developed a scientific method for labor pedagogy, and in No 1 of the TsIT journal "Building the Labor Force" for 1926 in the article "Training Apparatus" by N. Ivanov a description is given of one of the first automated trainers ever created in our country for developing skills in the technique of hand filing of machine parts. In the event of incorrect actions warning signals were given--in other words, continuous monitoring was achieved. A record was kept of mistakes. Training devices were also developed and applied for coordinating motions during lathe work, for carpentry work, for the textile, coal and other industries. The introduction of these devices made possible an acceleration of training averaging 60% and made it possible to prepare more than half a million qualified workers for the restoration of the economy, which had been devastated by war.

After 1928 the field of TsIT's activities was significantly expanded. Its methods began to be used not only in industry, but in the training of pilots for the Civil Air Fleet (GVF). For this, special training cabins were designed in which the pilot's actions during various flight conditions could be perfected.

In their development, trainers have gone through several generations. The evolution from one generation to another is accompanied by fundamental changes in the potential for training and in the design of trainers.

At first trainers for preparing operators of man-machine systems were built to train individual specialists in their personal tasks of controlling various stages of technological processes (instrument flying, synchronizing generators). Such trainers were developed on the basis of physical models and of the most elementary electromechanical computing and decision-making devices. To evaluate the trainees' performance, a record was kept of any mistakes or deviations from the prescribed course of the technological process.

Further on, with the use of mathematical models, analog computer technology and more complex simulation devices, there was a significant expansion in the possibilities of representing in trainers time-dependent processes in various devices and systems. Radar and sonar trainers were developed, trainers for governing the motions of ships and aircraft, trainers for preparing electric power station operators and cosmonauts. It became possible to provide group training for specialists working interdependently. Conditions of the external environment began to be simulated with the help of motion picture projection devices, noise generators, and tilting platforms.

With the appearance of, and use in trainers of, digital computers, television and laser technology, trainer design attained its present-day level of development. With these developments, the circumstances of the operators' work on actual equipment in various states of the environment can be much more fully simulated, in cases of possible failure of the systems and with simultaneous use of several of the various devices available to the operators. Monitoring

of the trainees' actions is now performed with consideration of psychophysiological indicators, and control of the training process has been automated.

Present-day trainer design, in solving problems of providing training for crews of spacecraft, aircraft and ships, for operating personnel of large electric power stations, for military specialists and for others, has begun to be distinguished as an independent field of technology. This distinction is facilitated by a whole-system approach to the design of trainers, with consideration given to pedagogical, engineering-psychological and technical requirements.

In the field of trainer design, the latest achievements of science and technology are put to use. A fundamental trend in the new developments in the field of trainer design has been the creation of training-simulation models of new spacecraft, of modern aircraft, of ships and of high-tech processes, on the basis of a broad use of electronic, microprocessor and television technology, a broad use in trainers of lasers, sound effects, tilting platforms with many degrees of freedom, etc.

The production of trainers is growing constantly. Centers for the training of operators have been established, well equipped with trainers and trainer technology. Methods of instruction on trainers are being perfected.

What is a modern trainer?

State Standards (GOST) define a trainer as a technical device for the professional preparation of a human operator, intended for the inculcation and development in trainees of professional knowledge and skills which will be necessary in order for them to operate some concrete device, by means of repeated execution by the trainees of actions corresponding to those involved in the operation of the concrete device.

In a trainer a physical or functional model of the hardware of a man-machine system is created, along with a model of its interaction with the surrounding environment. In simulating a concrete situation in the form of a training data model, it becomes possible at each stage of training to isolate only that information which is necessary in the given situation, to simplify or complicate the training task depending on the trainee's success rate, to change parameters and time scale of the processes, speed of "motion" and distances to objectives, to create extreme conditions, emergencies and critical situations. Many of those which are simulated on trainers cannot be reproduced on real equipment (for example, emergency conditions in nuclear reactors, a ship having its hull pierced, etc.).

In addition, in trainers it is possible to stop the training process at any point in time to discuss the development of a situation and to analyze the decisions and actions of the trainee. It is possible to reproduce a necessary situation many times in order to instill the required skills in the trainee.

A trainer assures constant monitoring of the quality level of the trainee's actions, constant recording of his psychophysiological state, his level of training and the errors he has made, and constant changing of the parameters

of the equipment and processes to be governed. These data are recorded for analysis, in order to obtain objective evaluations and objective control of the training process as a whole.

On a trainer one can impose tasks for professional competitive selection, for elementary training of operators, for restoring lost skills, for heightening operators' professional qualifications, for retraining on new equipment, for studying new methods of operation, for solving investigative tasks of design, for analyzing situations which arise on real equipment, for finding optimal solutions, etc.

The makeup of a trainer is determined by its overall purpose, by the methods of training in general use, and by the concrete nature of the device to be controlled. Generally a trainer includes a modeling device (MU), an instructor's control panel (PRO), trainees' stations (RMO), devices for simulating the surrounding environment (SI), apparatus for monitoring and evaluation of the trainees' actions (AKO), and also communications among them.

The trainee's station is generally a control panel on which he carries out his functions, with control levers and display devices. The number of stations may be one, for individual training of one operator, or several, in trainers for group training of operators at one hierarchical level or at different levels, carrying out different functions.

The modeling device creates the instructional data model and processes the data which are used by the operator in the course of training. As a rule, the role of the modeling device is performed by a computer complex, in which changes over time in the device to be controlled or the process to be governed are modeled, and the state of the environment is determined. In the modeling device data is processed pertaining to the instructional process and impinging factors having to do with the solution of the given task are generated. Various physical models and specialized simulators are also used as MU's: low-power electrical systems, electronic signal and noise generators, etc.

Simulation of the surrounding environment takes place with the help of small-scale mockups of localities, projection devices, noise simulators, and tilting platforms.

The instructor's station includes the instructor's control panel and the monitoring and evaluation apparatus. On the PRO are concentrated the control and monitoring devices for the computer complex, controls for the specialized models and simulation devices, controls which allow input of initial conditions, control of time scale, monitoring of the status of the device to be controlled and of the trainees' actions, imposition of emergency situations, issuance of hints, playing the parts of missing members of a team of operators, etc. For monitoring, storing and reproducing data on the quality of the trainees' work and on their psychophysiological state, printers, data recorders, audio tape recorders, graph plotters and other apparatus is used. The trainees' and instructor's stations are equipped with means of communication. With the help of the above-named apparatus the instructor keeps track of the functioning of all the apparatus of the trainer and guides the course of the training efficiently.

In order to lessen the load on the instructor, some of the functions involved in evaluation and in guiding the course of the training can be accomplished automatically with the help of the computer equipment used in the trainer.

The GOST outlines five fundamental points of distinction for classifying trainers: by purpose, by number of simultaneous trainees, by type of accomodation required, by degree of customization to the individual characteristics of the trainees, and by degree of automation of the training process.

By purpose, trainers are divided into specialized trainers and comprehensive trainers. Specialized trainers are intended for professional preparation of equipment operators in some specialty, for example an airman, a sonar operator, a telegrapher. Comprehensive trainers provide simultaneous preparation for several operators who interact among themselves, for example the pilots, navigator and mechanic of an aircraft, the operators of the boiler, turbine and electrical sections of a power station, or the captain, helmsman, sonarman and mechanic of a fishing craft, etc.

Trainers can be created for both individual and group trainers. They can be made stationary or portable.

In automatic trainers, the recording and analysis of the level of training attained and of the trainee's mistakes, and also control of the training process itself according to some chosen criterion, with consideration of the individual characteristics of the trainee, takes place without involving the instructor. A high degree of automation is possible in simple trainers for developing skills in elementary operations involving data input into computers, finding a signal against a background of noise, etc. In more complicated trainers, automation is a means for lightening, but not eliminating, the creative work of the instructor.

The economy of resources resulting from the use of trainers is attained on account of the smaller expenditures involved in building and exploiting them by comparison with the use for training purposes of real equipment. A large economic benefit is obtained due to the shortening of training time and improvement in the quality of training of operators of man-machine systems, inasmuch as the use of trainers allows one to simulate various situations which on real equipment would be difficult to create or downright impossible.

Trainers are especially economical in preparing operators of complicated and expensive systems, and also in training drivers of transportation equipment.

Comparing expenditures on the building and use of many different types of trainers, for example aviation trainers, marine trainers, etc., with the expenditures involved in training on real equipment, shows that in the first case (aviation) these expenditures are smaller by a factor of 8 to 10. As a rule, expenditures on trainers recoup themselves within one or two years of use.

Depending on the fullness of the modeling, the cost, for example, of an aviation trainer, according to foreign data, might be in the range of $3000 (for developing skills in working with the instruments) to $5-7 million (for a

complete preparation of the crew of an aircraft). In the last case, the retraining of airmen for service on a new aircraft might take place entirely on the trainer without any supplementary training in the air. The cost of one hour of flight time on a T-38 aircraft is $500, while the cost of one hour of work on the trainer is $65-75 in all. Thanks to the use of trainers in training airmen in the USAF, for example, 90,000 hours of flight time and 94.5 million tons of fuel have been saved (reference 11).

In the GVF the use of trainers has permitted a shortening by a factor of 2-2.5 the training time of a flight crew and of the personnel of a flight control team, and a heightening by 30%-40% of their level of training. The time required to recoup expenditures, for example for a trainer for a Tu-154 aircraft, amounts to 1.35 years. Fuel economy has reached 1500 tons per year (reference 12).

The use of trainers has brought about large savings for the training section of the Kiev TTU in the training of drivers for urban public transportation. The use of streetcar trainers has allowed a shortening of training time by 20%-25%. The economy has been achieved as a result of reducing expenditures on driver training and from the use of training vehicles for carrying passengers. The level of modeling in the urban public transportation vehicle trainers does not exceed 70%-80% (reference 12).

In the training of operators for atomic electric power stations, the duration of training on a trainer is shorter than that on an actual station by a factor of three. In the USA, in the training of operators for nuclear electric power stations (AES), it is considered necessary for each trainee to take part in two startups and two shutdowns of the nuclear reactor. The idle time of the AES, necessary for two startups, amounts to 12 hours, costs $25,000, and leads to an annual lowering of output of electric power of a minimum of 2%. The losses incurred in training on a trainer are substantially less, and the quality of preparation is higher, since on a trainer one can practice actions to be performed in case of emergency (reference 8).

The economic effectiveness of the use of trainers is heightened on account of the higher coefficient of load obtained by the use of them in operator training centers (TsPO). With concentration of trainers and personnel at TsPO, an improvement can be achieved in the organizational-methodological use of trainers, and expenses can be lessened. In a TsPO it is possible to create trainer systems--interconnected assemblies of trainers designed on the basis of multiuser computer and data management devices, which allow the possibility of growth in the number of new trainers and an expansion in the number of assignable training tasks.

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AUTOMATION HELPS MAN

Moscow MATERIALNO-TEKHNICHESKOYE SNABZHENIYE No 6, Dec 1985 pp 47-49

[Article by K. Leet, deputy chairman of the Estonian SSR Gossnab, and P. Silma, director of the Republic Computer Center]

[Text] At one of the collegia of the State Committee for Material and Technical Supply [Gossnab] the observation was made that the technical rearmament and reconstruction of enterprises applying modern automated systems is proceeding at an insufficient rate. The Gossnabs of the republics of the USSR, the principle regional managing bodies and their computing centers are not keeping to the necessary order in preparing its organizations for the introduction of automated management systems. And the body of problems set forth by the technical materials managers that has been resolved is broadening at a slow rate.

This refers to both the experimental development as well as the introduction of automated management systems into product delivery enterprises of the Gossnab of the Estonian SSR. For example, the automated management system of the universal base "Maardu" only processes bookkeeping tasks in batch mode. And this operation is not very effective. This is practically the mechanical duplication of hand-written documents. And for this, specialized personnel is needed at the computer center in order to prepare and store the data mechanically. Moreover, the accuracy of the conversion of the data from one medium to another must be ensured. The process of receiving and registration of the goods requires up to ten days, and invoicing the selection, shipping and accounting requires up to seven days. The statements are sent to the bank no earlier than on the fourth day after dispatch of the goods.

The automated management system "Metall," which has a more unified structure than "Maadru," has the same basic shortcoming. Although there are many programs for the computer, timely results do not come from them, as the data become obsolete because of the four-day processing cycle.

Both automated management systems resolve problems of "Automated Printing of Transport Overhead and Payment Requisitions." The idea itself for printing out initial documents on the computer is a good one. As a result of automating the output using keywords in a normative information system the manual labor involved in producing initial documents is reduced by 5 to 10

times. In addition, the documents are of a higher quality and contain data which, because of the large amount of work required, would simply not be included if they were hand-written, but are indispensable in performing some storage operations. In addition, goods managers, freed from mechanical work, can pay greater attention to duties purely associated with supply. Due to the absence of suitable equipment, the technology of, for example, consigning unsealed overhead transportable goods is unwieldy (requiring up to 12 operations, applying three different types of computer equipment), and is not very effective.

The large gap between the level of information processing achieved and that which is necessary for serving the market-supply organizations and the Gossnab of the Estonian SSR itself is primarily a result of the fact that the problems of operations control remain unresolved, and modern document processing technology is not being applied.

In defining the new technology, the authors took the following necessary conditions as a departure point: the application of a compact, inexpensive minicomputer, operating in real-time; the technical characteristics of the SM-4 as the the controller of the computer complex; the necessity for changing the enumeration as well as the statement of the problems, and the format of individual data; the advisability of automating the computer printing of packing slips as well as invoices, in order to free the goods manager from printing work; the necessity for delivery enterprises of first solving problems of operations management, which entails taking over the daily control of shipping and receiving, distribution, invoicing, selection, dispatching and payment for material goods, etc.

The primary functions of the system for automated management of production delivery enterprises were chosen: the introduction of guides for production, packaging, subdivisions, enterprises and ministries; the creation and automatation of invoicing for transport goods for centralized and planned self-output; operational management over goods in transport; accounting for fulfillment of contractual obligations; warehouse inventory; management of warehouse contents, and others.

Some of these functions are carried out in an interactive manner, by means of a dialog between the computer and the accountants, the goods departments and warehouses. Programs are called up by "menu," using a conventional designation. Ticket lists are output on the screen, close in form to the original documents the data are taken from. To make the conversion from the input process to the processes of correction, removal, and pagination an appropriate menu is displayed. In order to ease the process of inputting data into the database and to prevent false information from being entered, a number of categories for each input requisition are displayed, and the source of the information is collated with all possible arithmetic and logical controls. If incorrect operations are made, or if errors are detected, further work is prevented and appropriate words are displayed on the screen. Each requisition is put into the data base once. Principles of "deviation" are applied. For example, in inputting the dispatch to the warehouse, the worker selects the number of the transport-goods warehouse from a menu and the entire packing slip is displayed, and only the dispatch dates that deviate

from those planned are corrected. Principles of "prompting" are also applied: before a requisition is to be input, its most often used value is shown on the screen. The worker can then correct it, or, leaving the previous value, can move directly to inputting the next requisition.

The dialog regime was put into effect through the application of a modern database management system. Batch processing work is performed at the highest speed, as the printing of packing slips is done using typographically printed continuous-feed forms with a duplicate (or two, to make three copies). The cost of the good and its packaging, the sums of the price increases and reductions are automatically printed in itemized form as an addendum to the invoice, and not one operation is done by hand.

This data base allows the worker to inquire about the status of operations in each of the functions of the automated management system or as a whole, in the form of a summary, characterizing a tendency compared to a preceding period (day, week, or month). For example, the status of payments for a delivery of goods in transit, the status of a delivery and distribution of goods, the fulfillment of agreements by suppliers, the readiness of goods retrieved for shipment, the status of agreements fulfilled by product delivery enterprises, payments made by the consumers of goods received, and others.

Firstly, other than mechanically produced original documents, basic information and information about the status of the most important functions of the automated management system was devised. Also, official mechanically produced documents were developed for the ERO [expansion unknown] "Estkhimpishchesnabsbyt," the ERU [expnasion unknown] "Estlesbumsnabsbyt" and the ERU "Estmashsnabsbyt."

In 1986 the product delivery enterprises will add screen displays and reports along with new functions to the ASU. In connection with the broadening of this project to the ERU "Estmetallosnabsbyt" it will be supplemented by a definition of the total demand, by an account for transit, the payment of funds by the consumers, and others, without changing the characteristics of of the project that have already been developed.

Each product delivery enterprise production is characterized in the ASU by forty requisitions. Some of them have not yet been entered into the information base, and functions will be added to supplement it. Perhaps, for example, after determining and inputting the specific weight of an item into the computer, it is possible, knowing the conversion coefficient of any unit of measurement in tons, to move on to determine the necessary means of transport for shipping from the delivery enterprises for goods called for by the daily plan, and to connect the means of transport with the goods ready for shipping. This fact is registered on the display placed at a control checkpoint. By automating the additional account of basic stocks of low-value and short-lived items and materials, and of labor and wages, we can achieve a total automation of the bookkeeping for the product delivery enterprises. This is quite a real prospect, as the input and control of a large number of various documents is to be handled by accountants, who know the content and character of every requisition.

The realization of these plans is being hindered by the following: Due to an insufficient amount of computer memory for all 16 display terminals, the reaction time of the system to an inquiry increases when only four-seven people are using the system simultaneously. Therefore, the need has arisen to divide the computer time among groups of operators. The problem could be solved by replacing the current 1403 processor, which has 256KB memory, with the more powerful 1420 processor, which has 1MB memory [Translator's note: The author refers to the SM-1403 and SM-1420]. A weak point in the system are the 29MB disk drives, which often need adjustment and therefore prevent interchangeability among them, which is a necessary condition to increase the stability of a real-time system. The type of display terminal is also important. It must by noiseless, reliable and have multiple uses, such as the Hungarian VDT52130, which uses screen input-output to display the functions being performed by all programs. In order to decentralize the printing, Polish DZM180 printers, which connect to the VDTs, are appropriate.

The experience of designing and introducing this system has confirmed the possibility of creating a standard technology for all market supply organizations of the republic. This would allow the solution of the problem of automating workplaces in central bureaucratic departments, so that they and the higher organs of the government could take the information they need from all the automated management systems of the product delivery enterprises, without once converting the information by hand.

This technology is quite effective and can completely satisfy the growing needs of the information systems of the regional organs of the government. The processing cycle for invoices is shortened to one day (the statements go to the bank the following morning after shipment of the goods). In other words, the bank can utilize the funds arriving significantly earlier for the needs of other branches of the economy, and can shorten the amount of time for loans advanced to the product delivery enterprises themselves. Daily control over the status of stores in warehouses and over the operations of delivery, distribution, inventory, retrieval and shipment allow a more intensive utilization of the existing basic funds and an increase in the volume of deliveries, which leads to an increase in profits. In addition, the contents of the data base are "fresh": they characterize the actual status of the material and technical delivery enterprise for each day.

This technology is based on the use of automated workstations. Therefore, the retraining of cadres is important. The psychological barrier among various types of workers in adopting the new technology was surmounted as a result of the fact that it has been discussed at conference of the technical and economic soviet of the Gossnab of the Estonian SSR, and at workers' conferences led by product delivery enterprises. Short courses were organized, without interrupting production, primarily for managers of goods departments and warehouses. And with those already under way, courses were given individually for inputting each source of information and document and for outputting the information onto the display screen.

The automated management system project is being refined, corrected, supplemented and is being duplicated in the necessary number of copies on the computer itself. Copies are being made on magnetic tapes of operating systems,

user programs, descriptions of programs, processing technology and operations, of a model plan for measures for converting an item to the new technology, and other educational materials, without which it is impossible to introduce automated management systems into product delivery enterprises.

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UDC 517

BOOK: MATHEMATICAL METHODS FOR ANALYZING CONTROLLED PROCESSES

Leningrad MATEMATICHESKIYE METODY ANALIZA UPRAVLYAYEMYKH PROTSESSOV in Russian 1986 (signed to press 26 Jul 85) pp 1-2, 200-201, abstracts

[Annotation, Table of Contents and Abstracts from collection of articles "Mathematical Methods for Analyzing Controlled Processes," edited by N. Ye. Kirin, 1,271 copies, 212 pages.]

[Text] Annotation

This collection (number 8; number 7 was published in 1984) presents works on mathematical simulation, qualitative studies and optimization of control processes in dynamic systems. Special attention is paid to numerical methods for solving problems of presentation of and search for the best structures of controlling electromagnetic fields and to problems of controlling flying vehicles motion. The collection is intended for professionals in the fields of cybernetics, applied mathematics and control theory.

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UDC 517.9

ON DETERMINATION OF STATIONARY SELF-MATCHING FIELD OF CHARGED PARTICLES BEAM IN LONGITUDINAL MAGNETIC FIELD

[Synopsis of article by O.I. Drivotin and D.A. Ovsyannikov, pp 3-11]

It is proposed to specify particles distribution density in the space of particle movement integrals when solving the problem of a self-matching field of a charged particle beam. Sufficient conditions for applicability of this method of solving the problem are derived. As an example, a distribution is examined, for which a detailed analysis is conducted and a self-matching field in the form of a convergent series is derived. One reference.

UDC 537.533.33

CALCULATION OF ELECTRICAL FIELD FOR AXIALLY-SYMMETRIC ACCELERATING STRUCTURE

[Synopsis of article by N.V. Yegorov and S.V. Nebratenko, pp 11-25]

The article presents a method for calculating the electrical field in accelerating structures in the form of periodic systems of co-axial cylinders and diaphragms. The method is characterized by a rigorous solution of the problem of determining boundary conditions, derived with the help of methods

of the conformal transformations theory. It is demonstrated that the proposed method can also be used for calculating the field in periodic structures of quadrupol lenses. Eight references, two illustrations.

UDC 517.9

ALLOWING FOR COULOMB INTERACTION IN HIGH ENERGY PARTICLE BEAM

[Synopsis of article by A.P. Zhabko and V.M. Kalabutin, pp 25-31]

A model for taking into account Coulomb interaction in a high-energy particle beam is developed. It is proposed to replace the potential, created by the system of particles under consideration, by the potential of a uniformly charged ellipsoid which is an approximation of the system of particles in the "coordinates-velocity" phase space. This model makes it possible to simplify sets of equations that describe motions of interacting particles and thus reduce the time for computer simulation of beam dynamics in an accelerator. A numerical calculation is done, which makes it possible to compare the proposed model to the large particles method. One reference.

UDC 537.533

CALCULATION OF ELECTROSTATIC FIELD OF APERIODIC SYSTEM OF CYLINDERS

[Synopsis of article by T.P. Lebedeva, pp 31-34]

The article examines the first approximation of the asymptotics of a solution of a Laplace equation inside a system of co-axial conducting cylinders with equal radii that are located and charged in such a way that by replacing a cylindrical coordinate boundary conditions are reduced to periodic ones. In order to derive a solution in the series form and calculate coefficients, the Riemann-Gilbert method is used. Three references.

UDC 517

CALCULATION OF FIELD OF DRIFT TUBES IN PERIODIC STRUCTURE APPROXIMATION

[Synopsis of article by M.I. Letavin, pp 34-38]

The article describes FIELD 1 service for calculating potential in a periodic structure of drift tubes. The service is realized in the form of a procedure in the PL/1(F) language. Such service is required for checking applicability of simplified field formulas, used for calculating motion of charged particles in accelerators with drift tubes. Three references.

UDC 517.988.8

USING INTERMEDIATE PROBLEMS METHOD FOR SOLVING PROBLEM OF EIGENVALUES OF L-SHAPED MEMBRANE

[Synopsis of article by L.T. Poznyak pp 38-49]

The article demonstrates that it is possible to use Vaynshteyn's intermediate problems method for solving the problem of membrane eigenvalues and proves convergence of the method under the problem conditions. Eight references, one illustration.

UDC 517.9

ESTIMATING OUTPUT FUNCTIONAL OF SYSTEM WITH RANDOM INPUTS

[Synopsis of article by O.A. Tumak, pp 49-52]

The article examines the problem of deriving probabilistic estimates of output characteristics of differential equations with random inputs that describe motion of charged particles in linear accelerators. Within the correlation theory framework the article examines two reciprocal problems: determination of moment characteristics of output system parameters at a given probabilistic spread of input parameters and determination of probabilistic tolerances of input system parameters at a given spread of output parameters. The Monte Carlo (statistical testing) method is used. Five references.

UDC 519.24

CONSTRUCTION OF PARAMETRIC CHARACTERISTICS FOR ONE CLASS OF STOCHASTIC SYSTEMS

[Synopsis of article by V.L. Ustinov, pp 53-58]

The article examines parametric effects in systems with distributed parameters, described by hyperbolic-type equations. It presents expressions for parametric effects for cases of various correlation of parameters and various input actions. Eight references.

UDC 517.518

ESTIMATING CONSTANT IN N.P. KORNEYCHUK INEQUALITY

[Synopsis of article by I.B. Bashmakova, pp 59-64]

A sequence of algebraic polynomials $\{P_n\}_{n=1}^{\infty}$ is derived, such that for all $f \in C'([-1,1])$ and for all $x \in [-1,1]$ the following inequality is true:

$$|f'(x) - P_{n-1}(x)| \leq \frac{\pi^2}{32} \frac{\sqrt{1-x^2}}{n} \int_0^{\frac{\pi}{2}} \omega\left(f', \frac{2\sqrt{1-x^2}\,t}{n} + \frac{2t}{n^{4/3}}\right) + \frac{A}{n^{4/3}}\, \omega\left(f', \frac{\pi}{n}\right),$$

where ω is the continuity modulus and A is a constant. An analog of the inequality for a periodic case was derived by V.V. Zhuk. Four references.

UDC 62.50

ON VARIATION OF PARAMETERS OF LINEAR CONTROL SYSTEMS

[Synopsis of article by M.A. Galaktionov, pp 64-70].

The article substantiates a model that reflects the situation with variation of parameters in real-life control systems. It studies the model features that form a basis for making general estimates of the effect of variation of parameters on quality of functioning of a control system, closed by means of a regulator. Two references.

UDC 519.1

ON DECOMPOSITION OF GRAPHS

[Synopsis of article by V.F. Gorkovoy and M.Yu. Yegorov, pp 70-76]

Using the concept of graph presentation, the article studies the problem of Berge graphs decomposition over various algebraic operations. It makes an attempt to solve the inverse decomposition problem. Two references.

UDC 519.95

STABILIZING LINEAR NON-STATIONARY SYSTEM BY MEANS OF SCALAR FEEDBACK

[Synopsis of article by A.Ye. Guryanov, pp 76-84]

It is determined that a linear system with an integrally limited matrix of coefficients can be stabilized, using linear non-stationary scalar feedback with a choice of directions of control actions. Four references.

UDC 519.714

CONSTRUCTING DOMAINS USING CRITERION OF 1-STABILITY OF LINEAR SYSTEM

[Synopsis of article by V.M. Yesipov and S.P. Savelyev, pp 84-88]

The article examines a method for constructing feasible domain boundaries, using the criterion of 1- and φ-stability of a linear system. It proposes finding the domain boundary points in accordance with this criterion, using an equation for the determining root of a corresponding polynomial. Three references.

UDC 517.5

DESIGN CHARACTERISTICS OF CERTAIN CLASSES OF FUNCTIONS

[Synopsis of article by V.V. Zhuk, pp 88-94]

Let X be a space of 2π-periodic functions C or $L_p(1 \leq p < \infty)$, N - a set of natural numbers, N_n - a set of trigonometric polynomials of the order not higher than n, $E_n(f)_X = \min_{T \in H_n} \|f - T\|_X$, $B_{k,r}(f,x) = \pi^{-1} \int_{-\pi}^{\pi} f(x+t) \cos(kt + r\pi/2)\, dt$. The article derives a number of inequalities for derivatives of a periodic function and the function, conjugate of the latter. Corollary 2 serves as an example of the derived results.

C o r o l l a r y 2. Let $r, n+1 \in N$, $0 < \alpha < r$, $f \in X^{(r)}$. Then

$$E_n\Big(\sum_{k=1}^{\infty} k^{\alpha} B_{k,r}(f)\Big)_X \leq C_1(r,\alpha) E_n(f)_X^{1-\alpha/r} E_n(f^{(r)})_X^{\alpha/r},$$

where

$$C_1(r,\alpha) = \frac{r}{(r-\alpha)\alpha}\Big(\int_0^{\infty} \frac{\sin^r t}{t^{\alpha+1}}\, dt\Big)^{-1}.$$

Four references.

UDC 517.9

OBSERVABILITY OF DYNAMIC SYSTEM BY LINEAR APPROXIMATION

[Synopsis of article by Yu.V. Zaika, pp 94-105]

The article examines analytical observation systems. It identifies a class of systems with global observability by linear approximation and proposes a computational algorithm for solving the observation problem. Four references.

UDC 518.9

ON EXTREMAL PURSUIT PROBLEM

[Synopsis of article by A.V. Zatevakhin, pp 105-114]

The article examines a general pursuit model for controlled objects, whose movement is described by stationary sets of ordinary differential equations. It formulates a principle for constructing pursuer's control by the criterion of optimum damping of the absorption time. It also defines regualrity conditions in the speed of response problem and in the rendevoüz problem such that, when met, they result in an optimum control in the sense of minimax for the pursuer. Formation of control in a specific problem is examined. Three references, two illustrations.

UDC 517.9

OBSERVING QUASI-LINEAR SYSTEM

[Synopsis of article by A.P. Ivanov, pp 115-118]

The article defines conditions such that, when they met, the problem of observing a quasi-linear perturbed system has one and only one solution which is analytical relative to the perturbation. Two references.

UDC 519.95

ON THEORY OF ASSESSMENT METHODS IN DYNAMIC SYSTEMS

[Synopsis of article by N. Ye. Kirin, pp 118-125]

The article presents a unified approach to problems of identification, observability, forecasting and control in nonlinear dynamic systems. The method is based on constructing the problem of a conjugate functional, related to the solution of a transfer-type equation. As an illustration, the problem of nonlinear quadrature formulas is examined. Four references.

UDC 62.50

ON CONTROLLABILITY AND QUASI-CONTROLLABILITY

[Synopsis of article by A.I. Kiryanen, pp 126-129]

The article presents the necessary and sufficient conditions of controllability and quasi-controllability of linear stationary systems with a late-type aftereffect, as well as necessary conditions of complete contrallability of neutral-type systems. These criteria are expressed in

terms of restrictions on ranks of corresponding control matrices. The article aslo presents a criterion of stabilizability of a system with an aftereffect. Five references.

UDC 517.392

ON ERRORS OF CUBIC INTEGRATION FORMULAS IN CERTAIN CLASSES OF FUNCTIONS

[Synopsis of article by V.F. Kuzyutin, pp 130-133]

The error of a general type cubic formula is derived for a two-dimensional case for a given class of functions, examined in a unit circle. Four references.

UDC 518.9

DIFFERENTIAL GAME REACHABILITY DOMAINS

[Synopsis of article by S.Ye. Mikheyev, pp 133-146]

The article examines a differential game with two players that have simple motions in a simply connected domain G. By capture one means a situation, when the pursuer gets into the sphere of radius r > 0 around the pursuee, wherein the sphere must be inside G. The article proves that the set of pursuer's positions at moments of capture during the minimum time of its motion with constant velocity is a contour. The domain, bounded by the contour, is the reachability domain M, wherein $M(t_2) \subset M(t_1)\ \forall t_2 > t_1$, if at any moment the pursuer was choosing the fastest capture strategy, based on the hypothesis of the rectilinear motion of the pursuee from that moment on. Three references, four illustrations.

UDC 519.95

ON CONVERGENCE OF CERTAIN ALGORITHMS FOR SOLVING LINEAR SPEED OF RESPONSE PROBLEMS

[Synopsis of article by N.D. Morozkin, pp 147-154]

The article proposes a modification of N.Ye. Kirin's dual multispherical algorithm in problems of programmed linear speed of response. Using numerical examples, it compares the speed of convergence with already known algorithms (L. Neustadt' - J. Eaton, E. Fadden - E. Gilbert and B.N. Pshenichnyy - L.A. Sobolenko algorithm). Six references, two tables.

UDC 517.9

ASYMPTOTIC EXPANSION OF DIFERENTIAL EQUATION SOLUTION IN CRITICAL CASE

[Synopsis of article by S.L. Nosov, pp 154-157]

The article examines the following equation:

$$\dot{x} = F(x) + \varepsilon G(x),$$

where $F(x), G(x), x \in R^n, \varepsilon > 0$ is perturbation. It solves the problem of constructing the asymptotics of the solution of this equation over the time

interval $t \in [0, T/\varepsilon]$ with the initial data $x(0,\varepsilon) = x_0$ under the assumption that a nonperturbed system y = F(y) has an exponetially stable variety of rest points M_0, whereas x_0 is located within a sufficiently small vicinity thereof. Explicit equations for function $x_i(t), \tilde{x}_i(\tau)$ are derived. These equations belong to asymptotic presentation

$$x(t,\varepsilon) = \sum_{i=0}^{m} (x_i(t) + \tilde{x}_i(\varepsilon t))\varepsilon^{i} + O(\varepsilon^{m+1})$$

over the $t \in [0, T/\varepsilon]$ interval. Two references.

UDC 518:517.91/.94

NUMERICAL METHOD FOR INTEGRATION OF SETS OF ORDINARY DIFFERENTIAL EQUATIONS

[Synopsis of article by I.V. Olemskoy, pp 157-160]

The article examines an explicit single-step method for numerical integration of sets of ordinary differential equations that have the following form:

$$\frac{dy_1}{dx} = f_1(x, y_1, \dots, y_n),$$

$$\frac{dy_i}{dx} = f_i(x, y_1, \dots, y_{i-1}, y_{m+1}, \dots, y_n), \quad i = 2, \dots, m,$$

$$\frac{dy_j}{dx} = f_j(x, y_1, \dots, y_{j-1}), \quad j = m+1, \dots, n,$$

where y_s, f_s, s = 1, ..., n are vector-functions. It presents a single-parameter family of calculation formulas of the fourth order of accuracy that require fewer calculations of the right sides of the set than the same type formulas in the Runge-Kutt method. Two references.

UDC 629.192.2

OBJECT CONTROL BASED ON CORRECTABLE MODEL

[Synopsis of article by Yu.Ya. Ostov, pp 160-167]

The article presents an example of construction of a simplified model in the terminal optimum control problem and assesses the model efficiency from the standpoint of the value of the functional that is being optimized. Three references.

UDC 517.925

INVESTIGATION OF ELECTROMECHANICAL SYSTEM

[Synopsis of article by L.V. Rakin, pp 167-171]

A nonlinear model of a two-axial string differential accelerometer is constructed. It takes into account the change in string lengths due to deflections thereof. The model is studied, using the averaging method. Three references.

UDC 517.9

LEBESGUE CONSTANTS IN LINEAR METHODS FOR SUMMATION OF MULTIPLE FOURIER SERIES ALONG POLYHEDRONS

[Synopsis of article by M.A. Skopina, pp 171-180]

The article examines asymptotic behavior of Lebesgue constants for a broad class of linear methods for summation of multiple Fourier series. Partial Fourier sums are taken along polyhedron homothets. The answer is expressed in terms of Fourier transform, and the exact value of the constant in the main term is calculated for a specific case. Seven references.

UDC 516:517

NUMERICAL STUDIES OF FLYING VEHICLE MOTION

[Synopsis of article by T.Ye. Ushkova, pp 181-186]

The article examines a set of differential equations of a special type that describe motion of a flying vehicle. It proposes an algorithm that makes it possible to reduce the time, required for plotting the object motion trajectories. The algorithm employs the fourth order Runge-Kutt method. This modification results in multifold reduction of computing time, required for plotting motion trajectories. Seven references.

UDC 517

ON SIMULATING DYNAMICS OF CHARGED PARTICLES ALLOWING FOR INTERACTION THEREOF

[Synopsis of article by N.S. Yedamenko, pp 187-189]

The article describes an algorithm for numerical simulation of three-dimensional dynamics of a charged particles beam. The algorithm takes into account a three-dimensional charge, using the method of large particles in linear accelerators with HF quadrupole focusing. Three references.

UDC 517.925.42

PERIODIC SOLUTION OF SYSTEM WITH HYSTERESIS

[Synopsis of article by A.M. Kamachkin, pp 189-191]

The article derives sufficient conditions for existence of self-excited oscillations with an attraction region, conjugate of the entire phase space, for a set of differential equations. The right side of the set includes terms that are linear relative to phase coordinates, and a relay hysteresis. Three references.

UDC 517

INVESTIGATING DYNAMICS OF CHARGED PARTICLES IN THE STARTING PORTION OF AN ACCELERATOR

[Synopsis of article by A.Ye. LUKYANOVA, pp 191-193]

The article examines dynamics of charged particles in the starting portion of

an accelerator, while taking into account the self-charge of the particle beam. It examines a model of the beam, presented in the form of a charged spheroid, thus reducing the problem to studying a set of ordinary differential equations. Two references.

UDC 517

NUMERICAL METHOD FOR SIMULATING DYNAMICS OF CHARGED PARTICLES BEAM

[Synopsis of article by S.V. Minayev, pp 193-195]

The article presents a numerical method for simulating motion of a charged particles beam in electric fields that takes into account the field, generated by the beam itself. This is done with the help of a method for deriving potential in the form of a solution of the Poisson equation. Three references.

UDC 517.929

ERGODIC THEORY FOR LINEAR DIFFERENTIAL EQUATION WITH RETARDED ARGUMENT

[Synopsis of article by Yu.V. Olemskoy, pp 195-197]

The article formulates a theory for a linear differential equation with a retarded argument. The equation is generated in the case of describing the neutron acceleration phenomenon. Two references.

12770
CSO: 1863/229

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